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(51) INT CL^7
G01S 5/14 // G01S 5/00

(52) UK CL (Edition V)
H4D DAB DPBC D267 D268 D549

(56) Documents Cited

GB 2347035 A	EP 0874248 A2
DE 029822493 U1	US 6266533 B1
US 6222483 B1	US 6188351 B1
US 6081229 A	US 6070078 A

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UK CL (Edition V) H4D, H4L
INT CL^7 G01S, H04Q
Other: ONLINE: EPODOC, JAPIO, WPI

(54) Abstract Title
Locating system having a GPS receiver combined with a mobile phone

(57) A locating system having a GPS receiver coupled to a mobile telephone communicates with a central computer though a telephone network. The central computer establishes the general location of the mobile telephone and transmits assistance data though the mobile telephone to the GPS receiver. The assistance data enables selection of the appropriate satellites for position determination. Positional data is obtained by the GPS receiver and transmitted to the central computer. The general location of the mobile telephone may be the location established when the telephone was last used. The positional data may be delivered to the central computer by SMS.

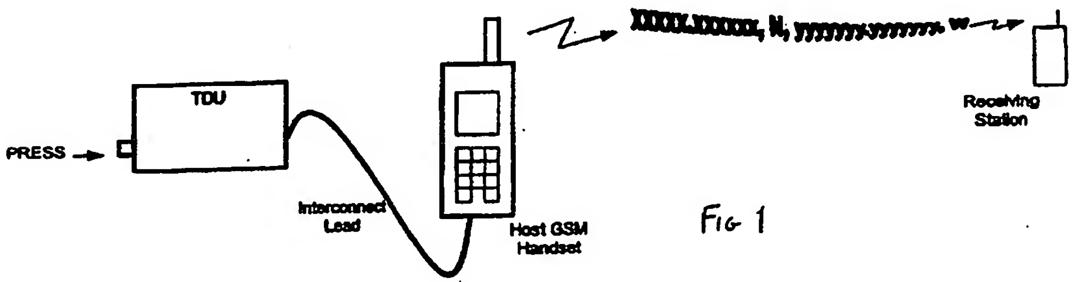

Fig 1

GB 2 380 343 A

The claims were filed later than the filing date but within the period prescribed by Rule 25(1) of the Patents Rules 1995.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

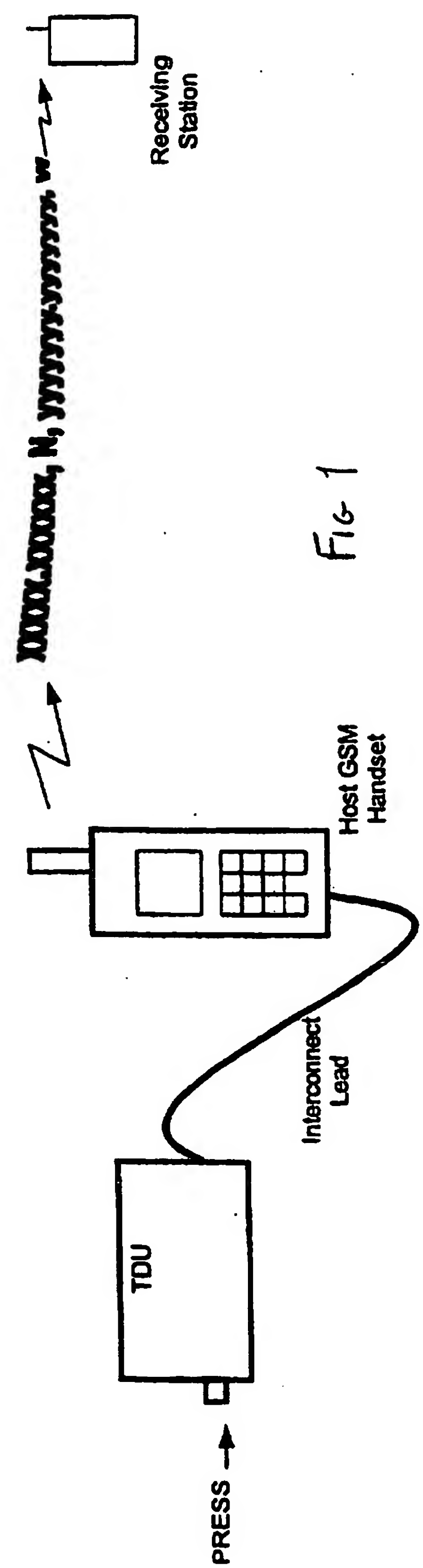
Receiving Station
XXXXX.XXXXXX, N, YYYYYY.YYYYYY, W
Host GSM Handset
Interconnect Lead
TDU
PRESS

FIG 1

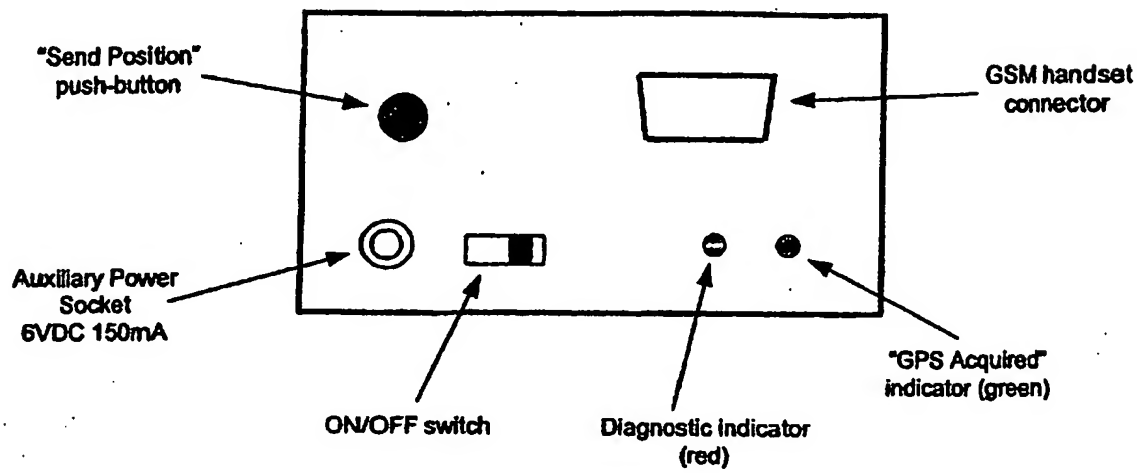
"Send Position" push-button
GSM handset connector
Auxiliary Power Socket 6VDC 150mA
ON/OFF switch
Diagnostic indicator (red)
"GPS Acquired" indicator (green)

FIG 2

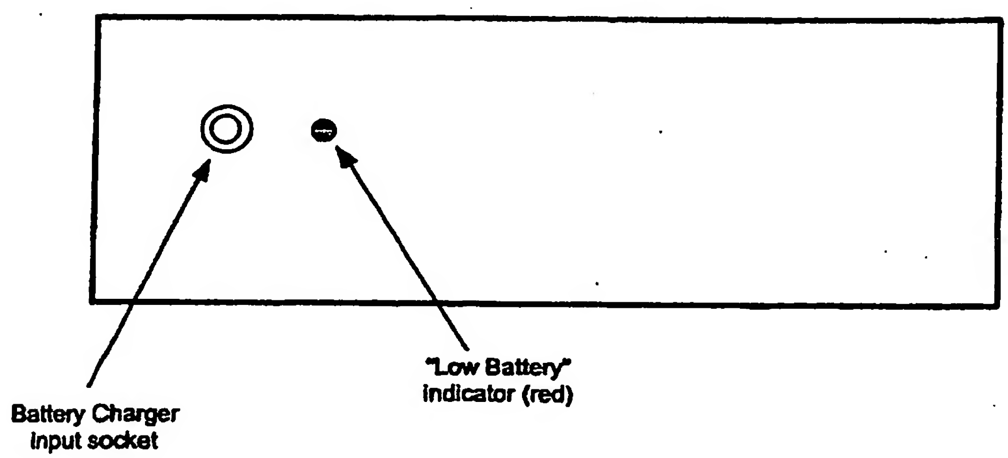
Battery Charger input socket
"Low Battery" indicator (red)

FIG 3

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Figure 4 Hardware Block Diagram

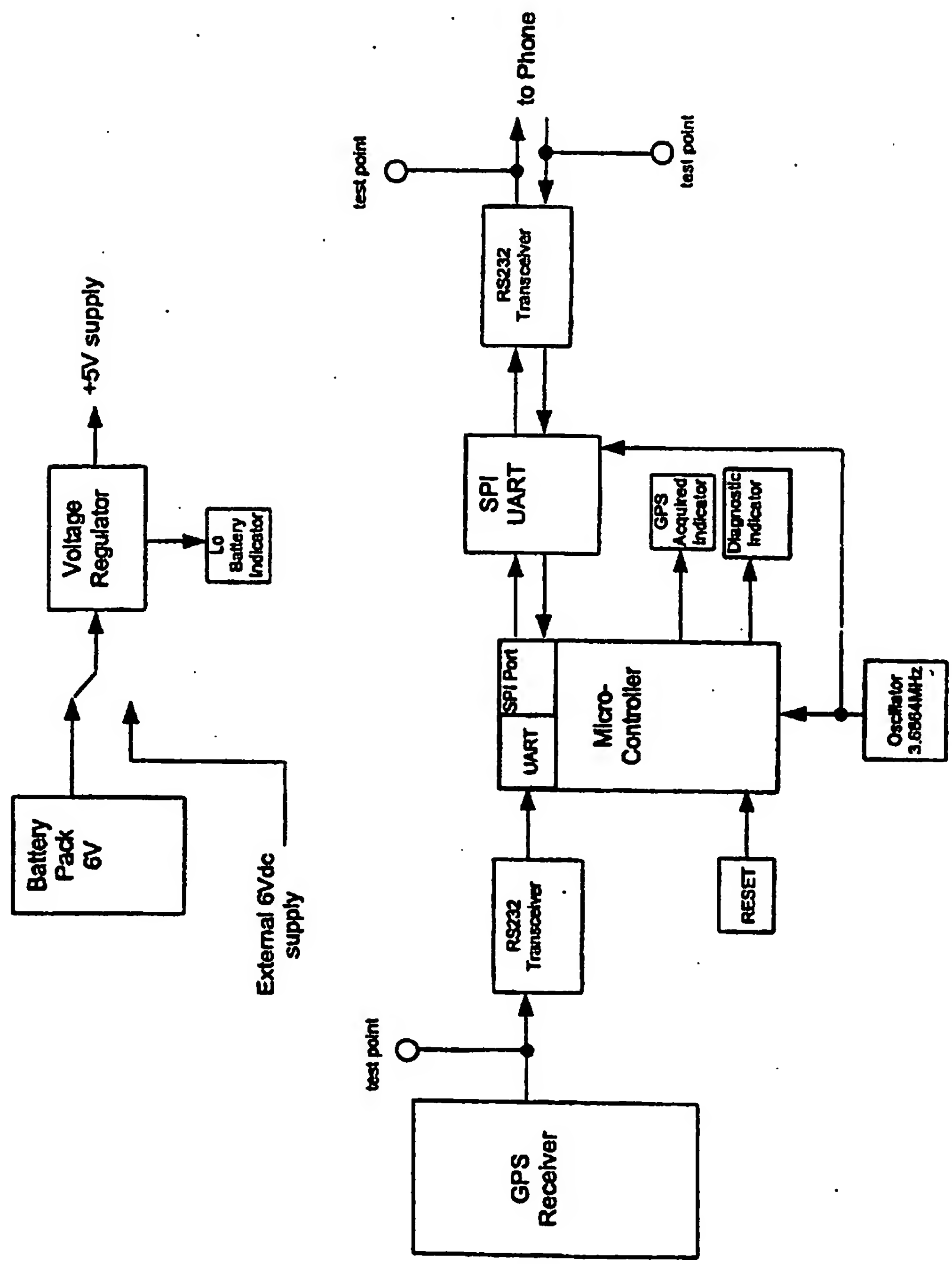

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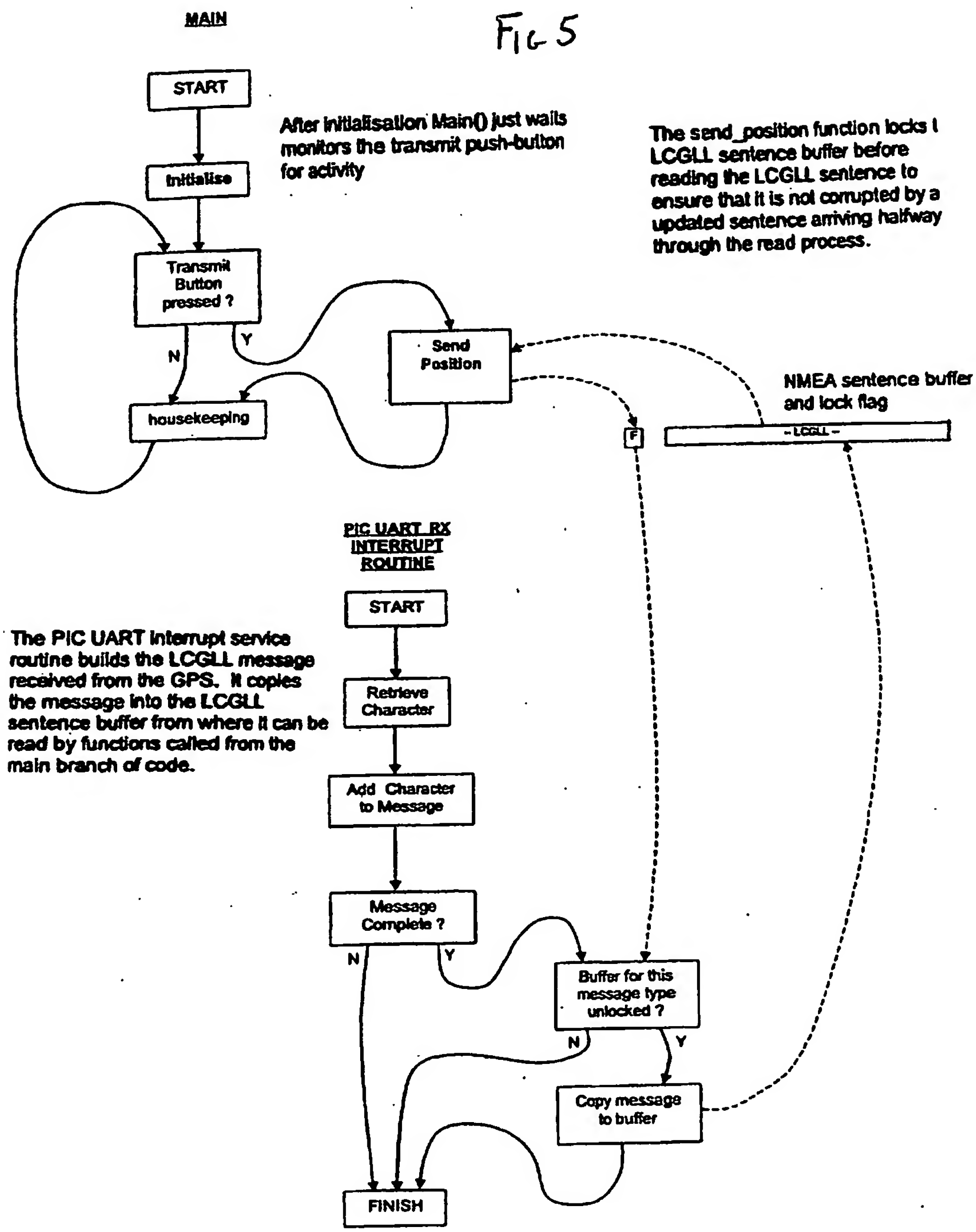
Fig 5


MAIN
START
Initialise
Transmit Button pressed ?
N
Y
Send Position
housekeeping
After initialisation Main() just waits monitors the transmit push-button for activity
The send_position function locks t LCGLL sentence buffer before reading the LCGLL sentence to ensure that it is not corrupted by a updated sentence arriving halfway through the read process.
NMEA sentence buffer and lock flag
F
- LCGLL -
PIC UART RX INTERRUPT ROUTINE
START
Retrieve Character
Add Character to Message
Message Complete ?
N
Y
Buffer for this message type unlocked ?
N
Y
Copy message to buffer
FINISH
The PIC UART interrupt service routine builds the LCGLL message received from the GPS. It copies the message into the LCGLL sentence buffer from where it can be read by functions called from the main branch of code.

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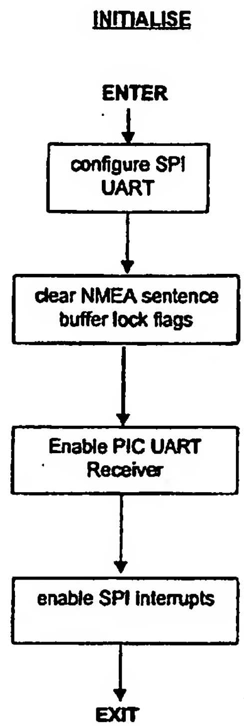

FIG 6

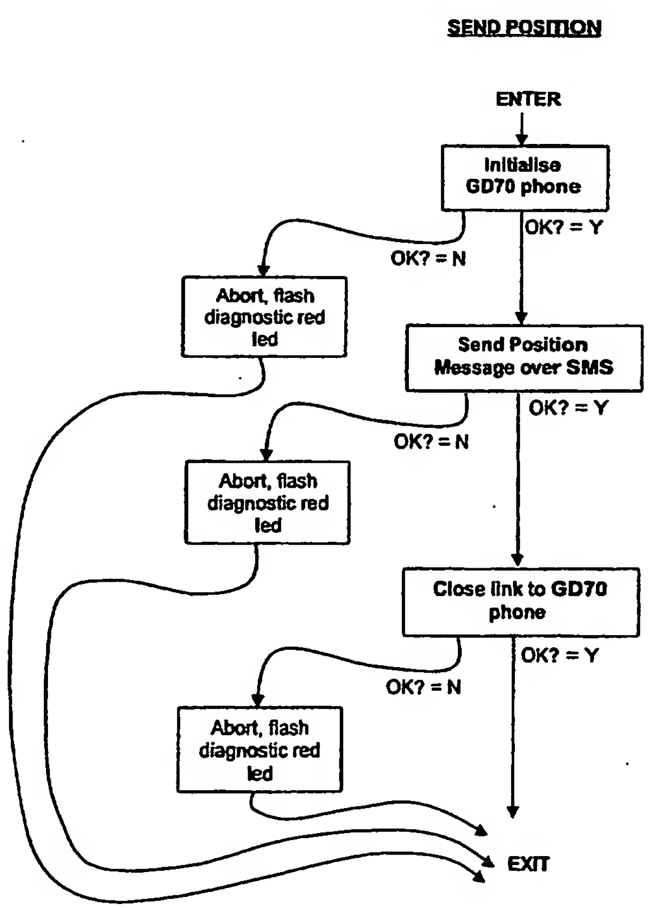

FIG 7

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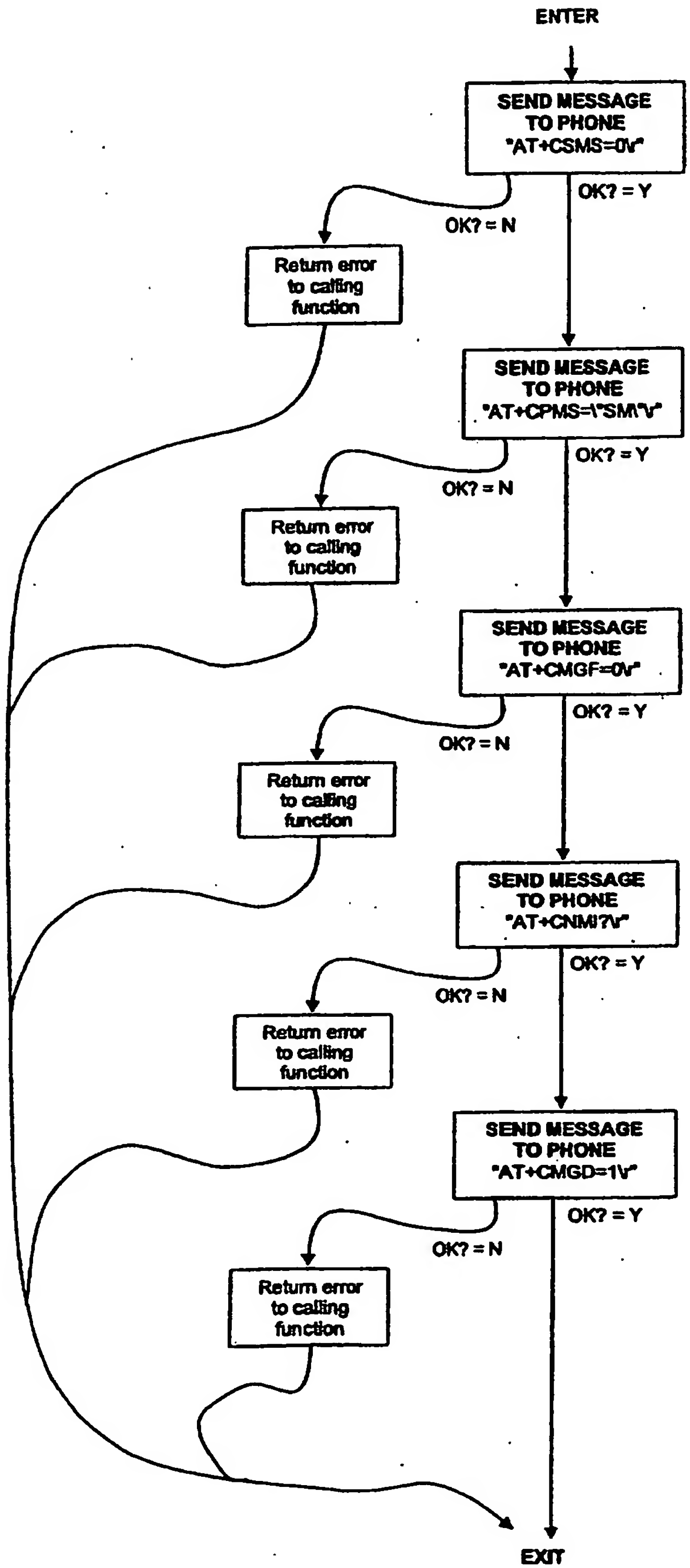

Initialise GD70 implements the "Opening Flow" specified in Panasonic specification "EB-G600/GD70 AT Command Functional Specification"

FIG 8

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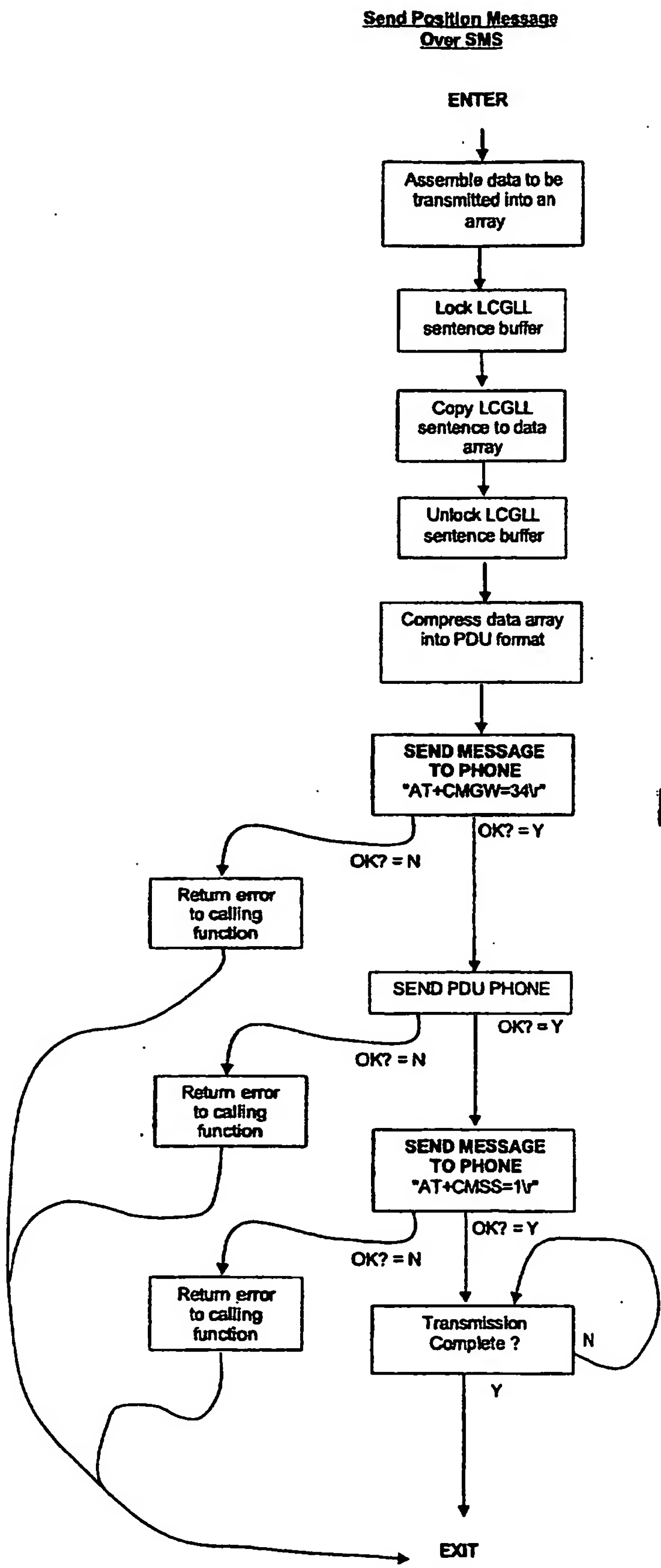
Send Position Message
Over SMS
ENTER
Assemble data to be transmitted into an array
Lock LCGLL sentence buffer
Copy LCGLL sentence to data array
Unlock LCGLL sentence buffer
Compress data array into PDU format
SEND MESSAGE TO PHONE "AT+CMGW=34\r"
OK? = Y
OK? = N
Return error to calling function
SEND PDU PHONE
OK? = Y
OK? = N
Return error to calling function
SEND MESSAGE TO PHONE "AT+CMSS=1\r"
OK? = Y
OK? = N
Return error to calling function
Transmission Complete ?
N
Y
EXIT

FIG 9

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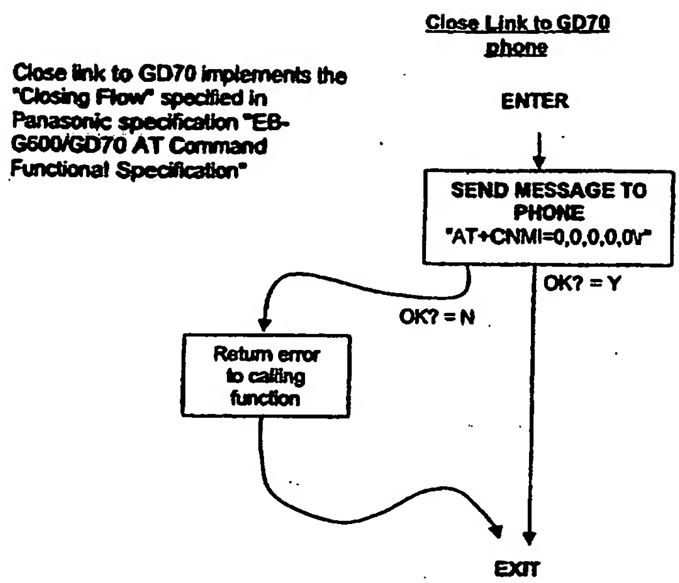
Close Link to GD70 phone
Close link to GD70 implements the "Closing Flow" specified in Panasonic specification "EB-G600/GD70 AT Command Functional Specification"
ENTER
SEND MESSAGE TO PHONE "AT+CNMI=0,0,0,0,0\r"
OK? = Y
OK? = N
Return error to calling function
EXIT

FIG 10

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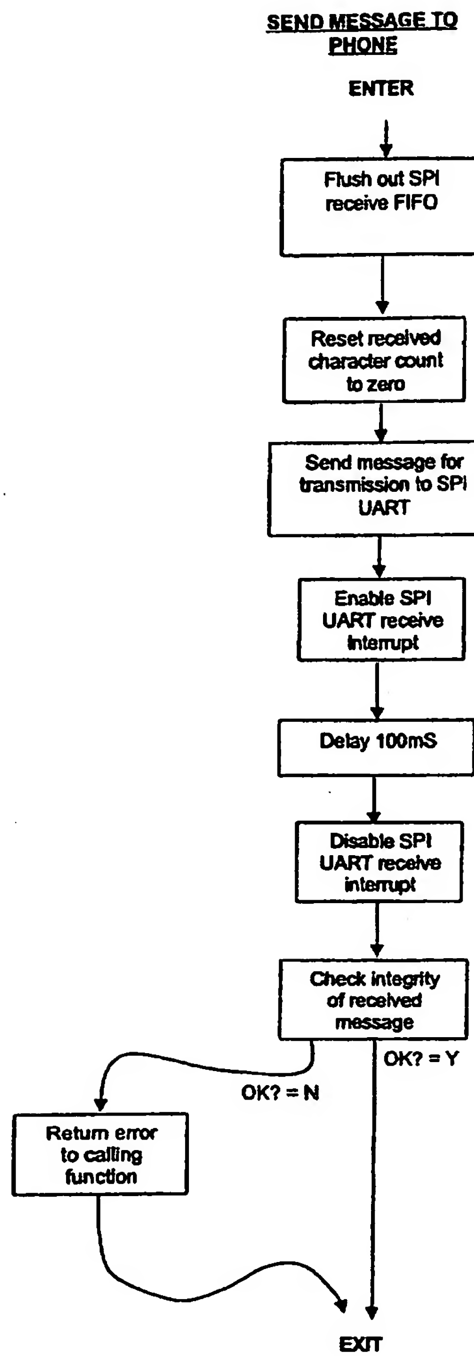
SEND MESSAGE TO PHONE
ENTER
Flush out SPI receive FIFO
Reset received character count to zero
Send message for transmission to SPI UART
Enable SPI UART receive interrupt
Delay 100mS
Disable SPI UART receive interrupt
Check integrity of received message
OK? = Y
OK? = N
Return error to calling function
EXIT

FIG 11

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Appendix A Circuit Schematic

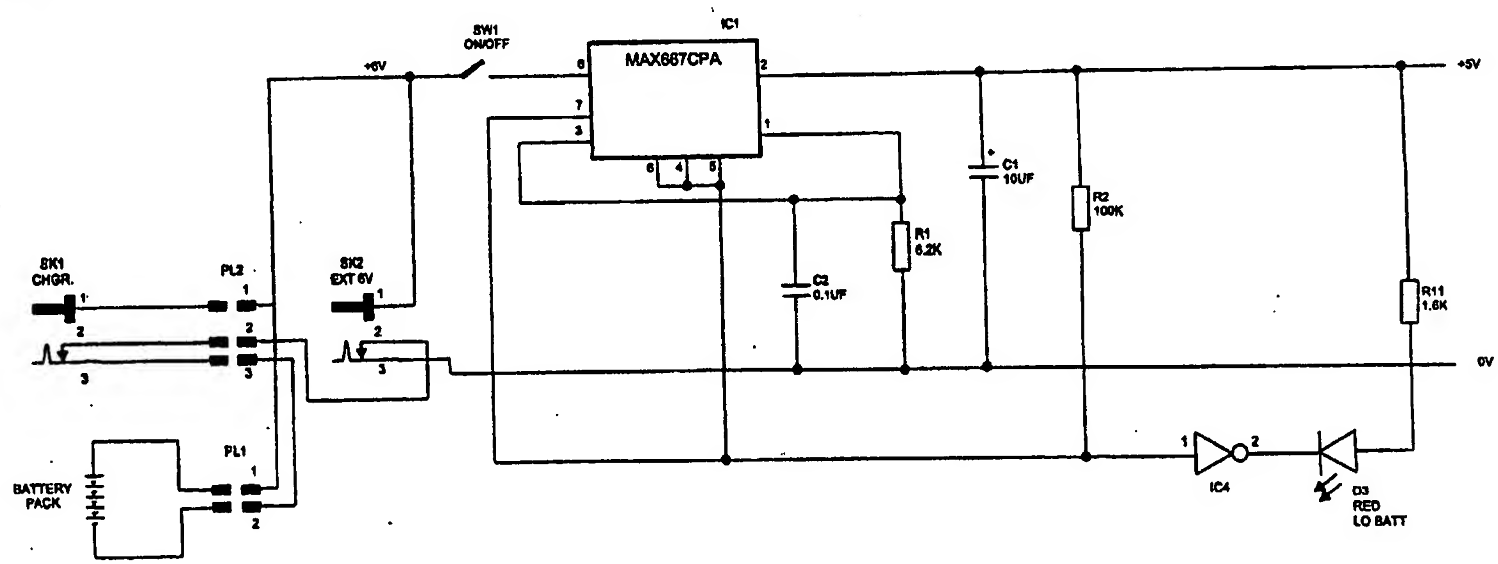

FIG 12

SMS/GPS Technology Demonstration Unit
Schematic Diagram
Sheet 1 of 2

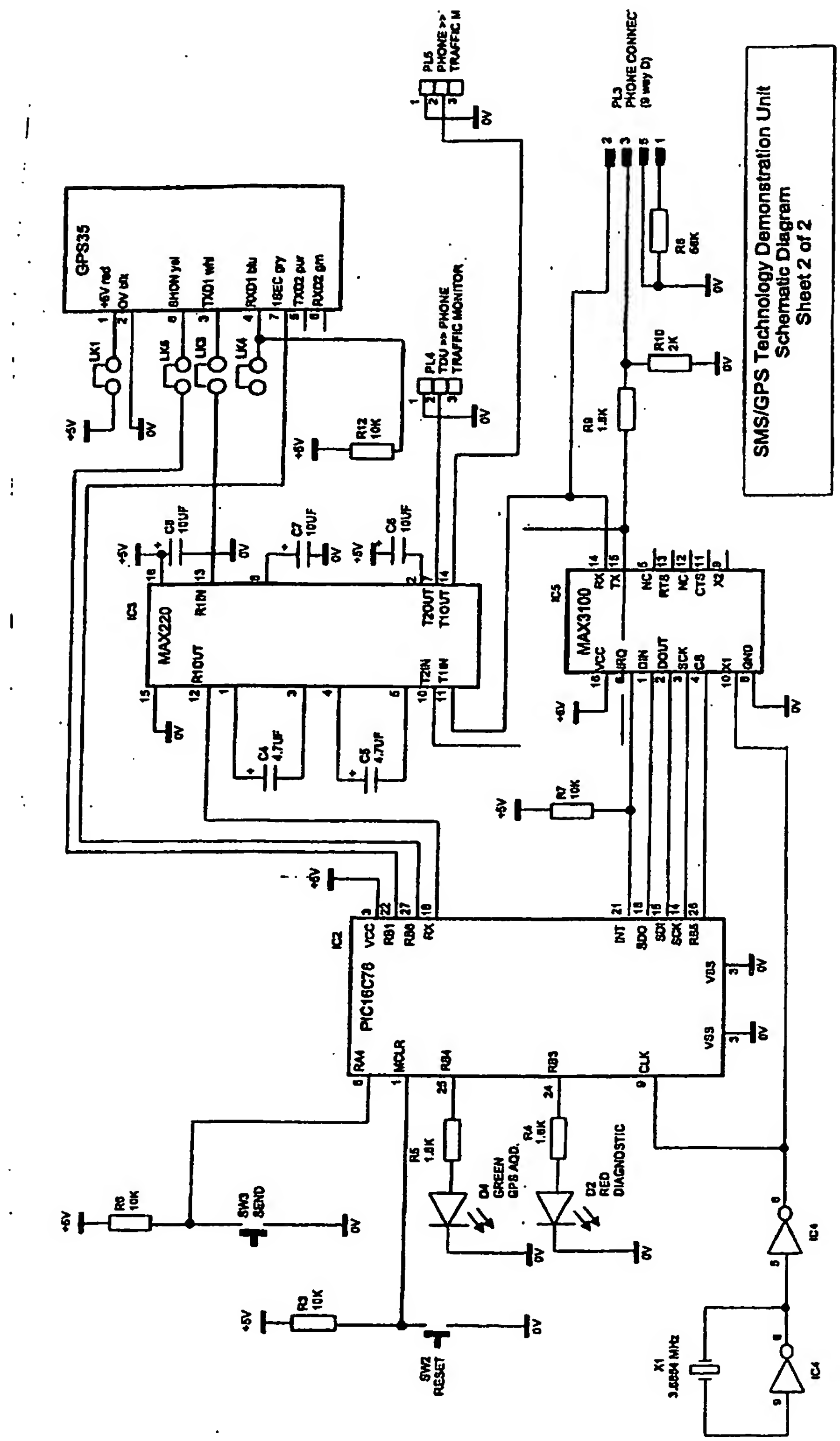
SMS/GPS Technology Demonstration Unit
Schematic Diagram
Sheet 2 of 2
GPS35
MAX220
MAX3100
PIC16C76
PL3 PHONE CONNEC (9 way D)
PL4 TDU >> PHONE TRAFFIC MONITOR
PL5 PHONE >> TRAFFIC M
SW2 RESET
SW3 SEND
D4 GREEN GPS AQD.
D2 RED DIAGNOSTIC
X1 3.6864 MHz

FIG 13

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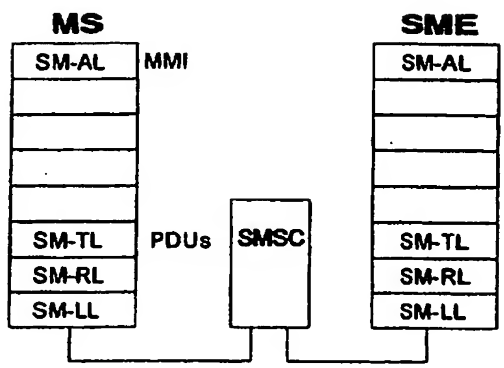
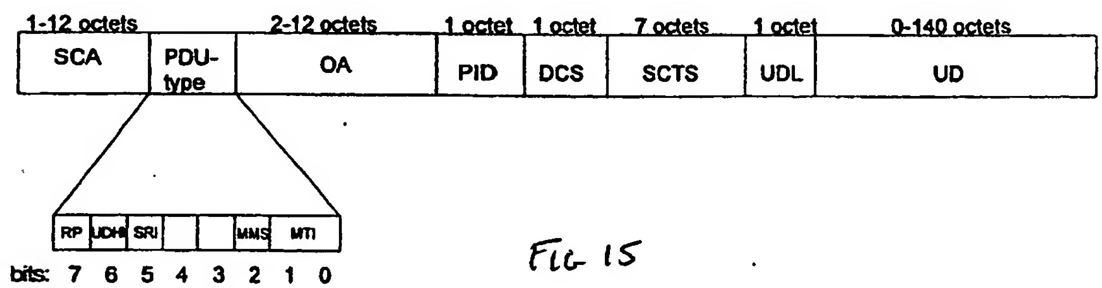


MS: Mobile Station
SME: Short Message Entity
SMSC: Short Message Service Center
MMI: Man Machine Interface
PDUs: Protocol Data Units
SM-AL: Short Message Aplication Layer
SM-TL: Short Message Transport Layer
SM-RL: Short Message Relay Layer
SM-LL: Short Message Link Layer

FIG 14



MTI bit 1 = 0
bit 0 = 0

FIG 15

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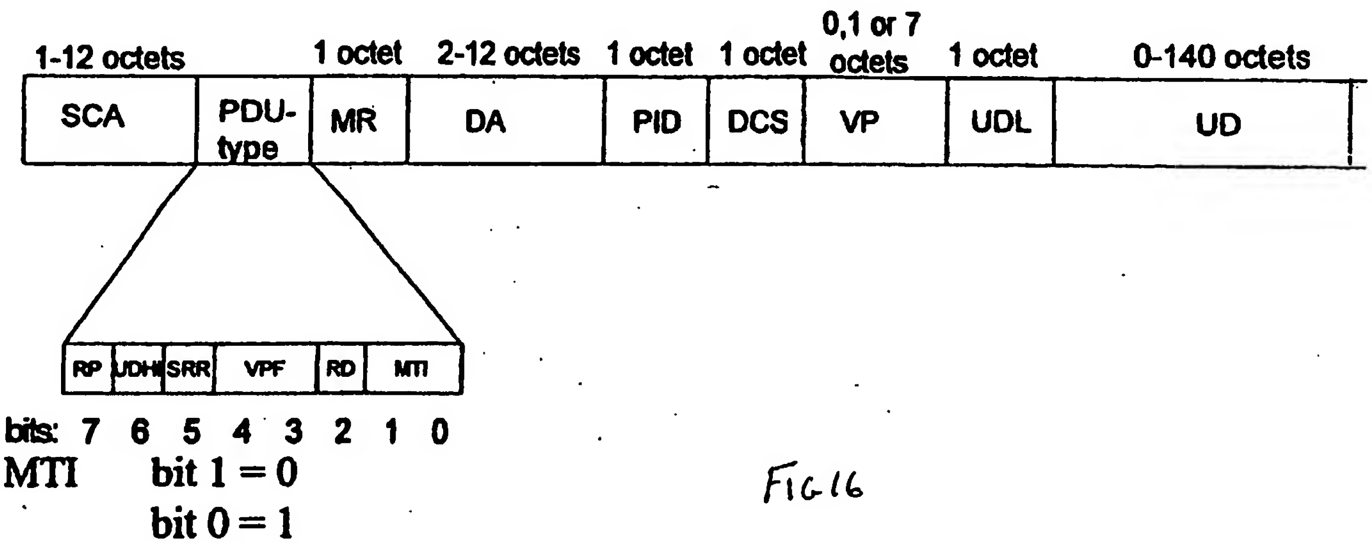
1-12 octets
1 octet
2-12 octets
1 octet
1 octet
0,1 or 7 octets
1 octet
0-140 octets
SCA
PDU-type
MR
DA
PID
DCS
VP
UDL
UD
RP
UDHI
SRR
VPF
RD
MTI
bits: 7 6 5 4 3 2 1 0
MTI bit 1 = 0
bit 0 = 1

FIG 16

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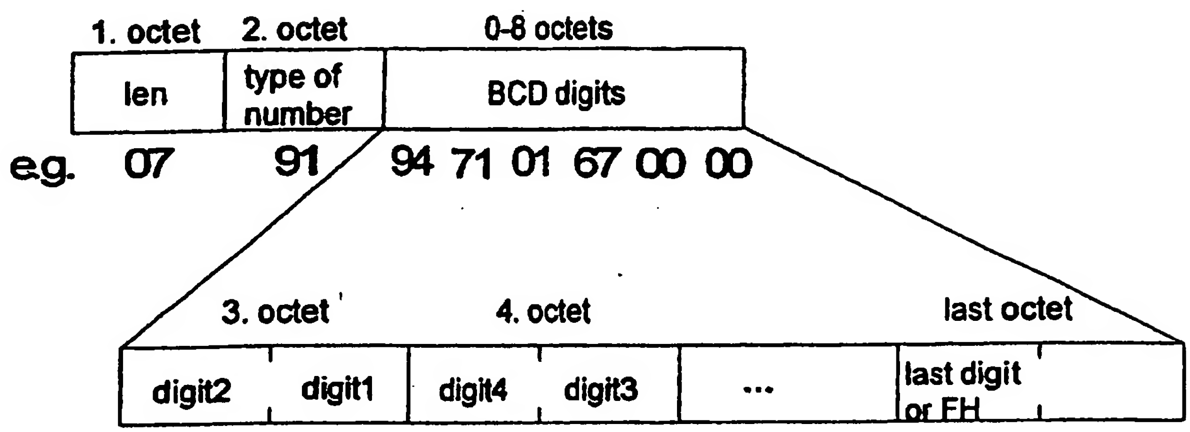

FIG 17

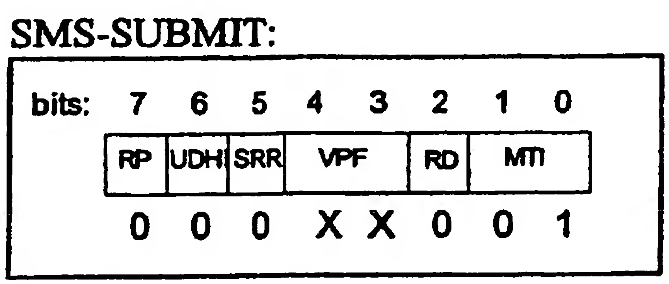

FIG 18

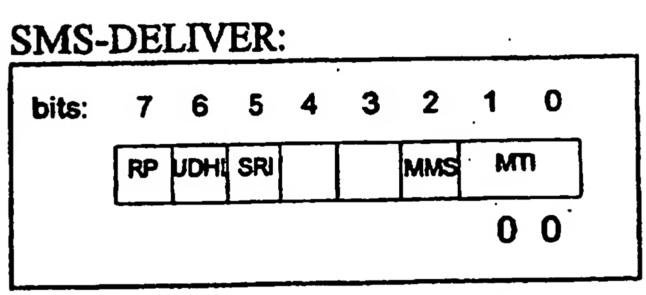

FIG 19

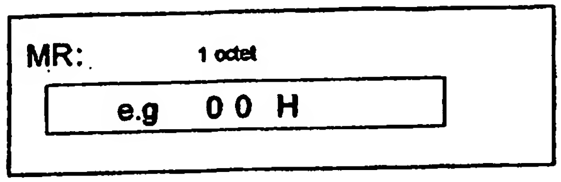

Fig 20

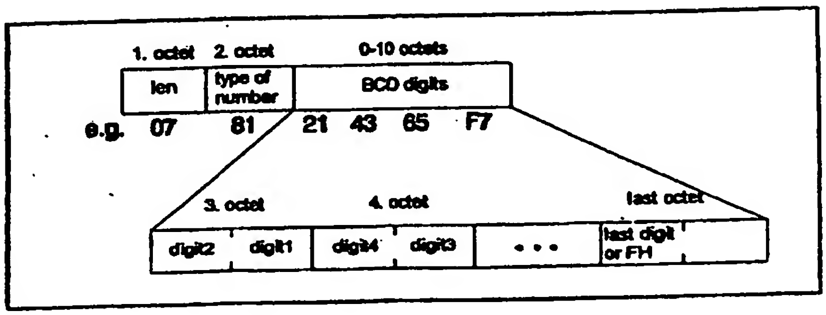

Fig 21

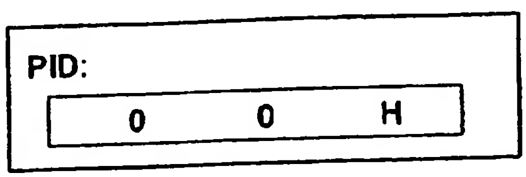

Fig 22

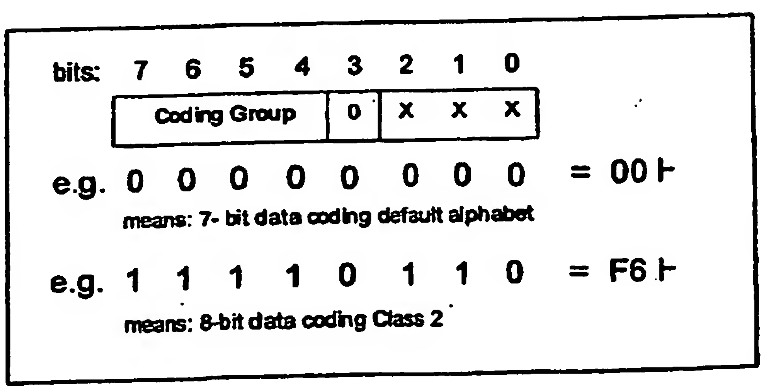

Fig 23

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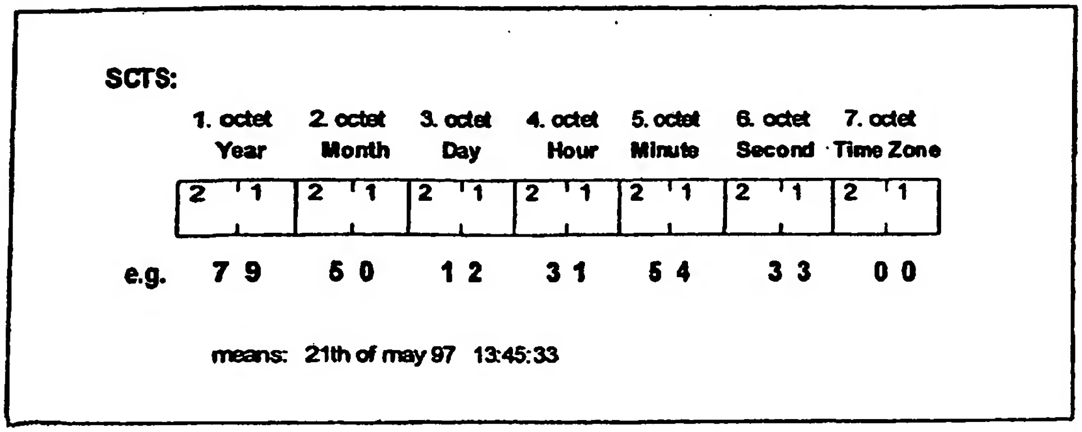

FIG 24

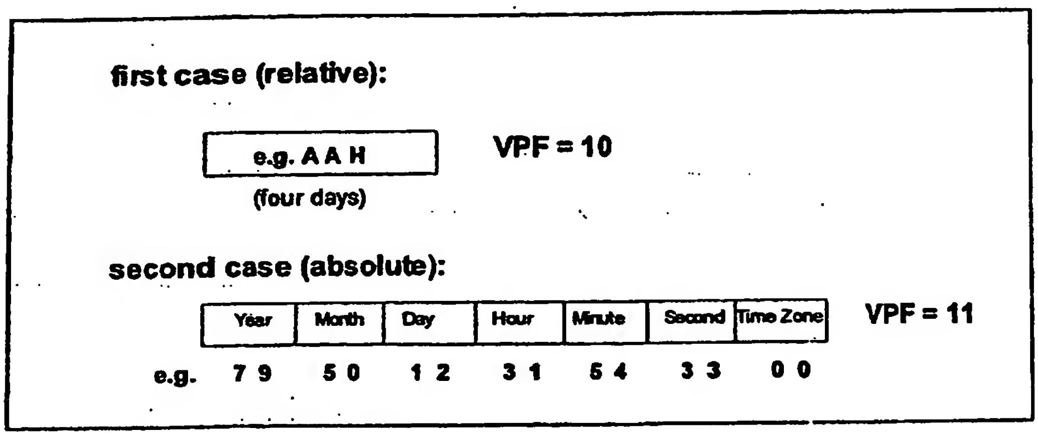

FIG 25

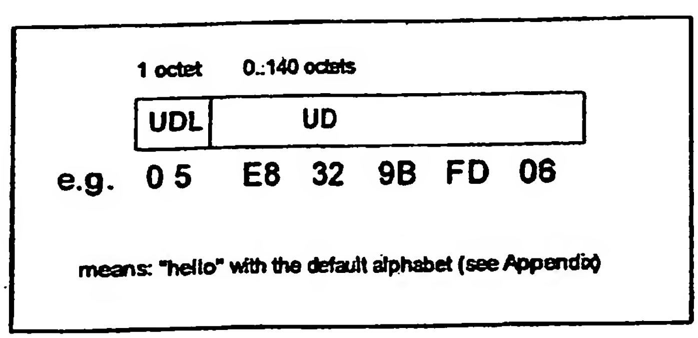

FIG 26

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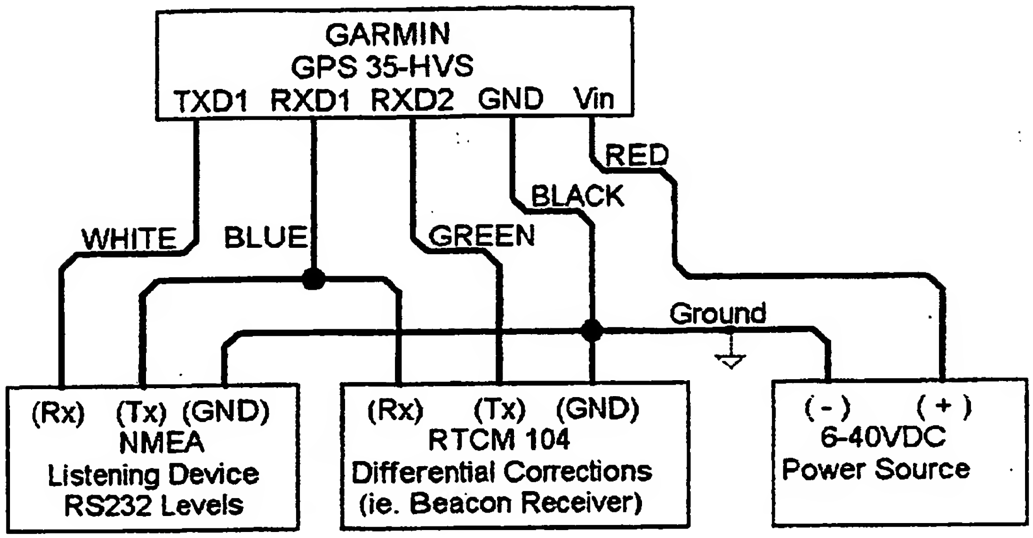

Fig.27. TYPICAL APPLICATION ARCHITECTURE

(General tolerance ±0.50mm)

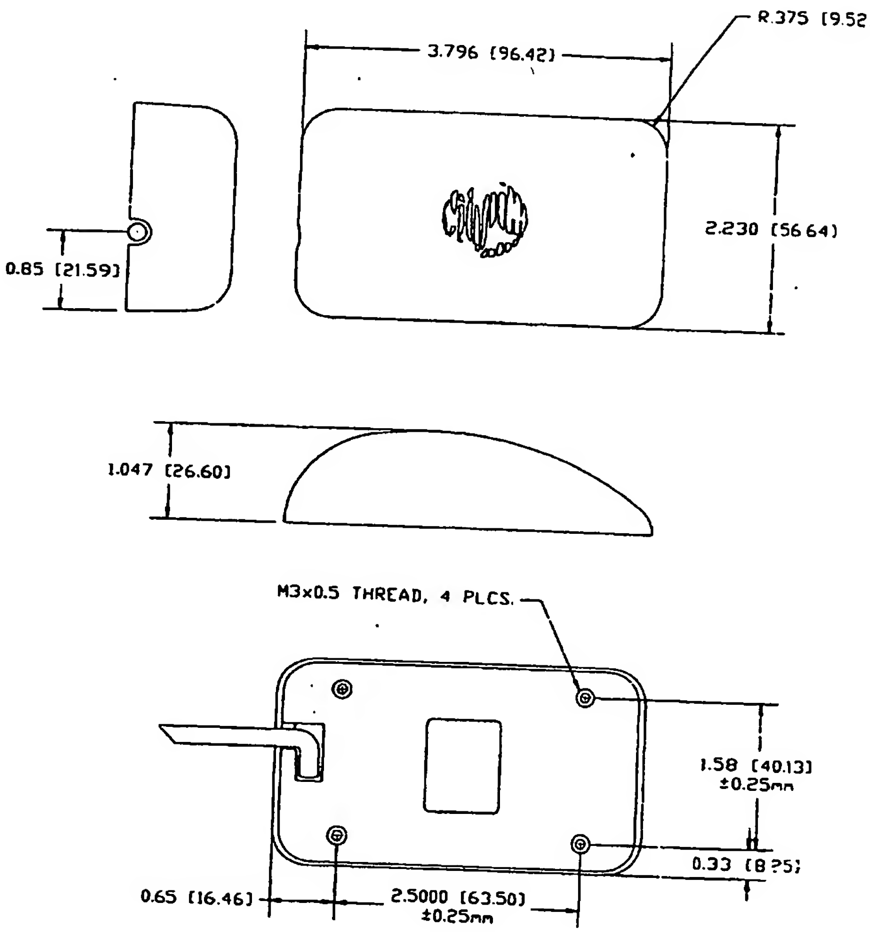

Fig 28 GPS 35LP Dimensions

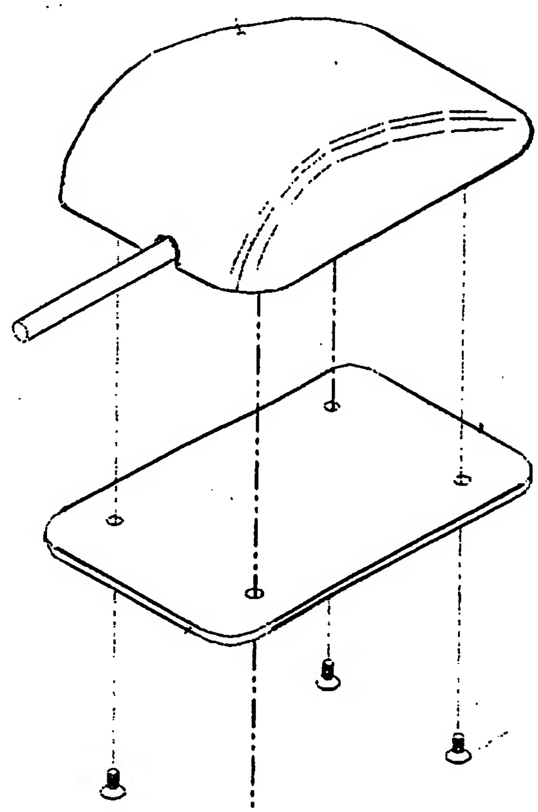

Fig.29 Magnetic Mount Attachment

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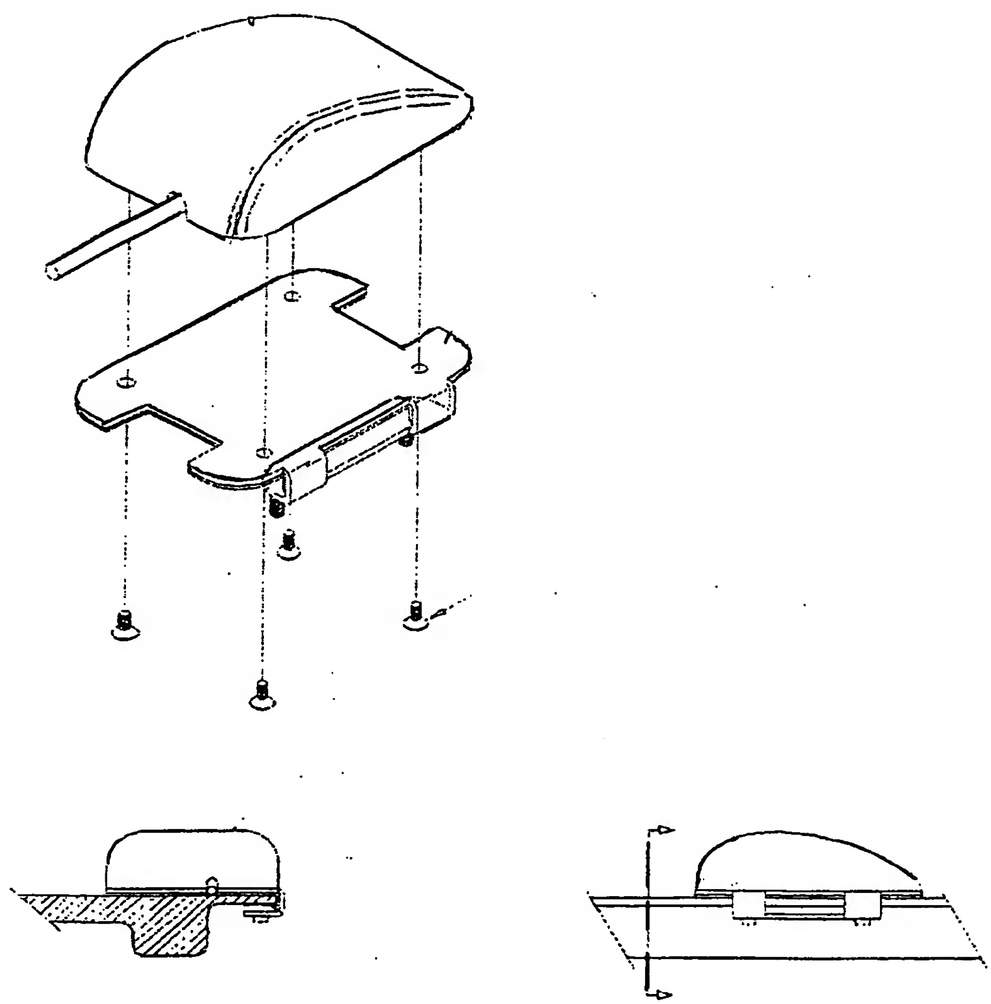


Fig 32 Trunk Lip Mount Attachment

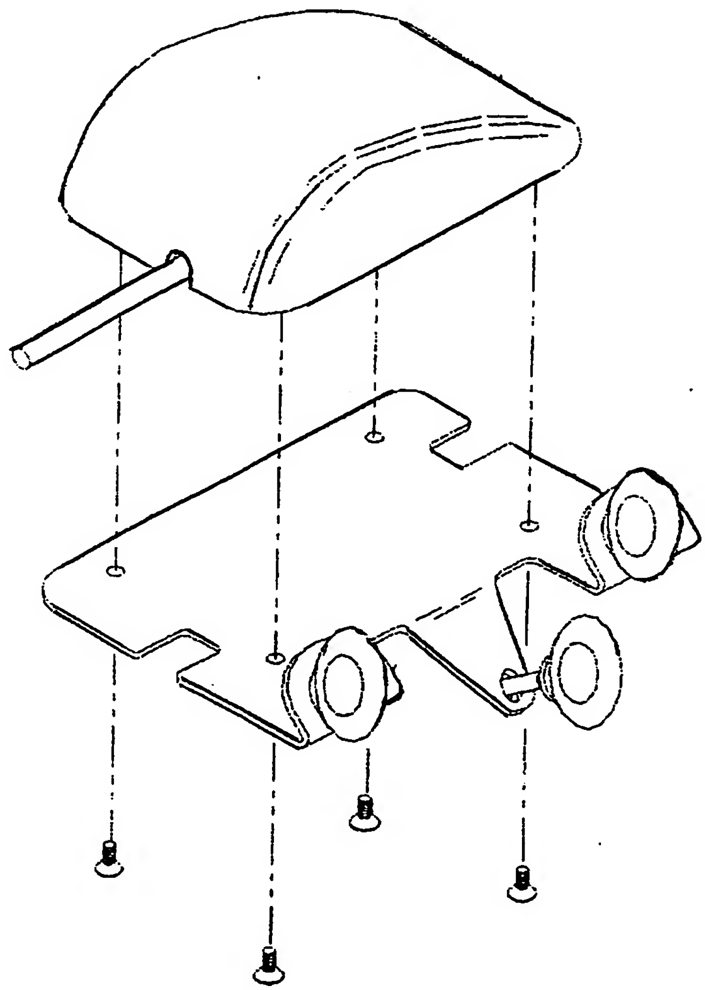


Fig.31. Suction Cup Mount Attachment

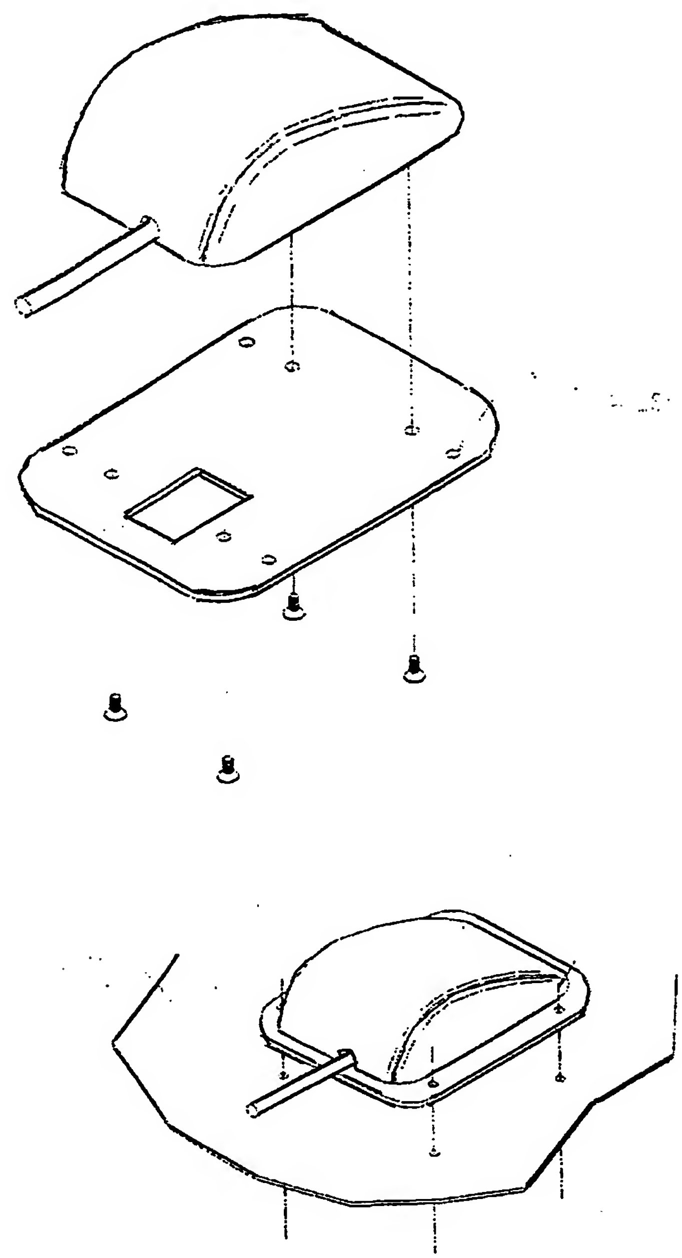


Fig32 Flange Mount Attachment

2380343

1 Introduction

This report describes the design of the SMS/GPS Technology Demonstrator Unit developed for CGL Technology Ltd, hereafter referred to as the TDU.

The TDU is connected to a GSM handset (mobile phone) and enables a user to report his/her position to a remote station with a single button push.

The TDU continuously reads position information from its internal Global Positioning System (GPS) receiver. When the button is pressed the TDU uses the host GSM handset to send its position, in longitude and latitude format, as a text message to a pre-programmed telephone number using the Short Message Service (SMS). This is depicted in Figure 1 General Arrangement.
1-1

The TDU is designed specifically for use with a Panasonic GD70 handset.

According to the present invention there is provided a demonstrator which revolves around the initialisation process.

According to the present invention there is provided a system using a mobile phone as a link to a central computer which can then feed back navigation data to the mobile phone on a piecemeal basis.

2 Handling

The TDU is a prototype electronic equipment. It contains hand built, discretely wired circuits rather than the more rugged printed circuit boards that would be used in a production version. The TDU should be considered fragile and handled with care.

The TDU contains electrostatic discharge (ESD) sensitive devices and should be opened only by qualified personnel at an ESD protected workstation.

3-1 3-2

3 Instructions for Use

The following instructions explain how to use the TDU. Figure 2 Front Panel and Figure 3 Side Panel show the controls, indicators and connectors on the TDU.

3.1 To send position

- connect the TDU to the GD70 handset using the supplied interconnect lead
- switch on the GD70
- wait for the GD70 to find the network (ready to make calls)
- switch on the TDU
- observe the red diagnostic indicator – it will flash at a rate of 0.25 to 1.0Hz indicating that the TDU is functional
- observe the green "GPS acquired" indicator: if it is illuminated the GPS is receiving updated positions every second and the current position of the TDU will be transmitted. If the green led fails to illuminate, the GPS receiver does not have an up-to-date position and the last known position will be transmitted.
- press the "Send Position" push-button: the position will be sent to the receiving station as an SMS call. During the call the red diagnostic indicator will cease flashing. There is no indication on the GD70 that the call is being made.
- once the position message has been sent the red diagnostic indicator will resume flashing

3.2 To Charge TDU Battery

The primary source of power for the TDU is a 500mAh 6V NiMH rechargeable battery pack. The battery pack provides power for approximately 2.5 hours from fully charged. The GPS receiver is the dominant load on the battery, drawing 120mA. To conserve battery power, switch on the TDU only when a position transmission is to be made.

The TDU may be powered from an auxiliary 6Vdc supply in the event that the battery is allowed to discharge completely. Note that the battery is not charged by the auxiliary supply.

The TDU battery pack is trickle charged with a standard NiCd charger. The time to fully charge the battery is 14 hours at 50mA. The TDU is not operational during charging.

The low battery indicator illuminates when the battery has approximately 1.5 hours life remaining and as such is not currently a reliable indicator of imminent battery failure. This shortcoming is attributable to the specific cells used in the battery pack which charge to 1.1V rather than 1.2V, the cell voltage expected from NiMH. It is envisaged that cells obtained from a different manufacturer would result in the low battery indicator operating correctly and illuminating with 0.5 hours operation remaining.

3.3 To Charge GPS Receiver Internal Lithium Battery

The GPS receiver in the TDU contains a rechargeable lithium battery that backs up memory containing satellite almanac data. The lithium battery is trickle charged whenever the TDU is switched on. If the lithium battery is allowed to fully discharge the almanac data will be lost and the GPS receiver will have to search the sky every time it is switched on. This will result in an increase in time to obtain a valid fix to 5 to 10 minutes.

In order to ensure that the lithium battery does not become fully discharged the TDU should be powered on for a period of at least 30 minutes every month *while the GPS receiver has a valid fix.*

4 Functional Description

4.1 GPS Receiver Functions

The GPS receiver, a Garmin GPS35, is a complex unit that acquires signals from the GPS satellites, via its own integral antenna, applies a complex processing algorithm and calculates the position of the unit in terms of longitude and latitude. It calculates position once per second and transmits this information as an ASCII string (NMEA sentence $LCGLL) to the microcontroller. The data transmitted also contains a field indicating whether the GPS receiver has been able to calculate a valid position given the prevalent signal reception conditions. If a valid fix is unobtainable the position data sent is that of the last known good position.

4.2 Microcontroller Functions

The microcontroller receives position data from the GPS receiver and stores it in memory. It illuminates the "GPS acquired" indicator if the position is valid. The microcontroller also monitors the state of the "send position" push-button. When it senses that the button has been depressed it:

- Converts the current position data to a format suitable for transmission over the GSM SMS system (PDU mode formatting)
- Initialises the mobile phone
- Sends the position data, in the form an SMS text message, to the preprogrammed telephone number.
- Note that the telephone number to which the position message is sent is programmed into the microcontroller's memory, not the mobile phone's

5 Hardware Description

The following description of the hardware design refers to the hardware block diagram shown in Figure 5-1 Hardware Block Diagram.

5.1 Battery Pack

The battery pack comprises five AAA 500mAh NiMH cells connected in series giving an output voltage of 6V. NiMH is used in preference to NiCd due to its higher capacity/volume ratio and reduced memory effect. When the battery charger is plugged into the TDU the battery is automatically disconnected from the TDU through the action of the charger input socket.

5.2 Regulator

The 6V supply from the battery is regulated to +5V by a Maxim MAX667 micropower voltage regulator. A micropower device was selected to minimise battery loading. This device also has an inbuilt low battery detector. As the battery voltage drops, the regulator drop-out voltage reduces. When the regulator is no longer able to regulate the low battery indicator is asserted and used to illuminate an LED on the front panel.

The regulated 5V supply powers the GPS receiver, microcontroller and ancillary electronics.

5.3 GPS Receiver

The GPS receiver is a Garmin GPS35-LVS. This is a fully integrated device, including an antenna, intended for use in OEM equipment applications. The LVS variant is powered from +3.6V to +6.0V and communicates with the host system via an RS232 asynchronous communications link.

Prior to installation the GPS35 is programmed, using the $PGRMO command to transmit only $PGRMT, $LCGLL and $GPRMC sentences at 4800 baud. The RS232 communications line can be broken by removing wire links LK3 and LK4. The GPS35 can then be connected to a PC serial port and an RS232 terminal program (such as Hypertyerminal) used to communicate with it.

The technical specification for the GPS35 is included as an appendix to this report.

5.4 Oscillator

An oscillator circuit with 3.6864MHz crystal provides the master clock signal to the microcontroller and SPI UART. The selection of 3.6864MHz provides:

- a relatively low microcontroller operating speed, which conserves battery power whiles providing sufficient processing power
- a convenient frequency source for the baud rate generators on the microcontroller and SPI UART.

5.5 Reset

Power on reset is automatic. Reset can be asserted manually by depressing a push-to-make switch connected across the reset header pins. A power up timer in the microcontroller is enabled at programming time. The power up timer holds off the internal microcontroller reset for 74mS after the +5V supply has settled, ensuring sufficient time for the oscillator to stabilise.

5.6 SPI UART

The SPI UART is a Maxim MAX3100.

It is included to provide a duplex asynchronous communications port to the GD70 phone (the microcontroller has just one UART and this is used to communicate with the GPS receiver). The microcontroller in turn communicates with the MAX3100 via an SPI link. It uses this link to configure and control the MAX3100. Messages to the phone are passed from the microcontroller to the MAX3100 for onward transmission. When the MAX3100 receives a character from the phone it

asserts the microcontroller interrupt; the microcontroller then interrogates the MAX3100 and retrieves the character.

The command set used by the microcontroller to communicate with the MAX3100 is specified in the MAX3100 datasheet this is included in an appendix to this report for reference.

Communications between the MAX3100 and the phone are at 9600 baud.

5.7 Microcontroller

The microcontroller is a Microchip PIC16C76JW. This is an 8-bit mid-range microcontroller with the following features:

- 20MHz max operating frequency
- 8kbytes onboard EPROM
- 364 bytes onboard RAM
- UART
- SPI port
- 2 timers
- miscellaneous I/O ports

The software is programmed into the onboard EPROM. Onboard RAM is used for data storage: RAM usage is approximately 90%.

5.8 RS232 Transceiver

A MAX220 is used to translate CMOS logic levels to/from the microcontroller into RS232 levels to/from the GPS receiver. It also provides translation to RS232 levels of the CMOS signals between the SPI UART and GD70 phone. These RS232 signals are available on test connectors so that they can be monitored, for development and debugging purposes, on a PC running a terminal program (eg Hyperterminal).

5.9 GPS Acquired Indicator

This is a green LED on the front panel that is illuminated by the microcontroller whenever the GPS has a valid fix i.e when the "V" flag in NMEA sentence $GPRMC reported by the GPS receiver is set.

5.10 Diagnostic Indicator

This is a red led mounted on the front panel used for various purposes to aid diagnostics during development: these include,

- toggle each time a $GPRMC sentence is received from the GPS receiver
- a burst of 5 quick flashes if an error occurs during the send position message sequence

When communicating with the GD70 phone the diagnostic indicator ceases flashing unless an error occurs. Flashing resumes when the phone call is complete.

6 Software Description

The software flow of control is shown in the following series of diagrams. Functions shown in bold type are in turn represented by a lower level flow diagram. Comments are included to aid in describing the general structure of the software.

These flow diagrams should be read in conjunction with:

- The source code, which is commented extensively
- Panasonic EB-G600/GD70 AT Command Functional Command Specification, for details of communications flow to and from the phone
- Siemens "SMS with the SMS PDU mode Developers Guide" and GSM03.38 for details of PDU data format

Abbreviations

CMOS	Complementary Metal Oxide Silicon
EPROM	Erasable Programmable Read Only Memory
GSM	Global System for Mobile communications
GPS	Global Positioning System
I/O	Input/Output
LED	Light Emitting Diode
NMEA	National Marine Electronics Association
RAM	Random Access Memory
SMS	Short Message Service
SPI	Synchronous Peripheral Interface
TDU	Technology Demonstrator Unit
UART	Universal Asynchronous Receiver/Transmitter

1. Introduction

To use the SMS you have to declare the number of the SMSC[1] (Short Message Service Center) in the MS (Mobile Station), provided that the MS support SMS-MO (Short Message Service-Mobile Orginated).
The SIEMENS **S25, SL10, S10, S10 active, E10, M1 Module** for example are providing SMS-MO.

card	SMSC-number (Germany)
D1	491710760000
D2	491722270000

At the MOBILE you enter the SMSC-number with the AT+Celular command:

at+csca = "<SMSC-number>"

If the receiver of the SMS possesses a D2 card, the AT command has to be entered in the following way:

at+csca = "+491722270000"

With the command

at+csca?

you can question the actual adjusted SMSC-number

Ask your network operator for the right SMSC-number !!

! notice: In addition to the AT+CSCA command it is possible to enter The SMSC-number in front of the Protocol Data Unit (PDU) see chapter 3.1!

OVERVIEW

SEE FIG 14

The MMI is based on the command set of AT+Cellular, and could be realized by means of a terminal (for example Triodata, Telix, WIN-Terminal) or the display of a handy.

The SM-TL provides a service to the Short Message Application Layer. This service enables the SM-AL to transfer short messages to its peer entity, receive short messages from its peer entity and receive reports about earlier requests for short messages to be transferred.
The SM-TL communicates with its peer entity with six several PDUs (Protocol Data Units):

- **SMS-DELIVER, conveying a short message from the SMSC to the MS**
- SMS-DELIVER-REPORT, conveying a failure cause (if necessary)
- **SMS-SUBMIT, conveying a short message from the MS to the SMSC**
- SMS-SUBMIT-REPORT, conveying a failure cause (if necessary)
- SMS-STATUS-REPORT, conveying a status report from the SMSC to the MS
- SMS-COMMAND, conveying a command from the MS to the SMSC

The SMS-DELIVER and SMS-SUBMIT PDUs are described in the following sections.

2.1 SMS-DELIVER (Mobile Terminated)

SEE FIG 15

2.2 SMS-SUBMIT (Mobile Originated)

SEE FIG 16

! notice: Any unused bits will be set to zero by the sending entity and will be ignored by the receiving entity !

SCA	Service Center Adress - information element	Telephone number of the Service Center
PDU Type	Protocol Data Unit Type	
MR	Message Reference	sucessive number (0..255) of all SMS-SUBMIT Frames set by the MOBILE
OA	Originator Adress	Adress of the originating SME
DA	Destination Adress	Adress of the destination SME
PID	Protocol Identifier	Parameter showing the SMSC how to process the SM (as FAX, Voice etc)
DCS	Data Coding Scheme	Parameter identifying the coding scheme within the User Data (UD)
SCTS	Service Center Time Stamp	Parameter identifying time when the SMSC received the message
VP	Validity Period	Parameter identifying the time from where the message is no longer valid in the SMSC
UDL	User Data Length	Parameter indicating the length of the UD-field
UD	User Data	Data of the SM
RP	Reply Path	Parameter indicating that Reply Path exists
UDHI	User Data Header Indicator	Parameter indicating that the UD field contains a header
SRI	Status Report Indication	Parameter indicating if the SME has requested a status report
SRR	Status Report Request	Parameter indicating if the MS has requested a status report
VPF	Validity Period Format	Parameter indicating whether or not the VP field is present
MMS	More Messages to Send	Parameter indicating whether or not there are more messages to send
RD	Reject Duplicate	
MTI	Message Type Indicator	Parameter describing the message type 00 means SMS-DELIVER 01 means SMS-SUBMIT

3. Parameter description

3.1 Service Center adress information element (SCA info element)

SEE FIG 17

len:
The octet "len" contains the number of octets reqiured for the number of the Service Center plus the 1 byte „type of number"

type of number:
81H: the following number is national
91H: the following number international
(for further information see GSM 04.08 chapter 10.5.4.6)

octet:
One octet includes two BCD-digit Fields
If the called party BCD number contains an odd number of digits, the last digit shall be filled with an end mark coded as "FH"

Example:
if you have the SC-number +49 171 0760000 you have to type:

07919471016700000

! notice: If the „len" field is set to Zero the MOBILE takes the default value of the Service Center adress set by the AT+CSCA command!

3.2 Protocol Data Unit Type (PDU Type)

SEE FIGS 18 + 19

! notice: you have to write the PDU-type in Hex-Format, a possible example is "11H" !

RP:	0	**Reply Path parameter is not set in this PDU**
	1	**Reply Path parameter is set in this PDU**

UDHI:	**0**	**The UD field contains only the short message**
	1	**The beginning of the UD field contains a header in addition of the short message**

SRI: (is only set by the SMSC)

0	A status report will not be returned to the SME
1	A status report will be returned to the SME

SRR:	**0**	**A status report is not requested**
	1	**A status report is requested**

VPF:	bit4	bit3	
	0	**0**	**VP field is not present**
	0	1	Reserved
	1	**0**	**VP field present an integer represented (relative)**
	1	**1**	**VP field present an semi-octet represented (absolute)**

any reserved values may be rejected by the SMSC

MMS: (is only set by the SMSC)

0	More messages are waiting for the MS in the SMSC
1	No more messages are waiting for the MS in the SMSC

RD:	**0**	**Instruct the SMSC to accept an SMS-SUBMIT for an short message still held in the SMSC which has the same MR and DA as a previosly submitted short message from the same OA.**
	1	**Instruct the SMSC to reject an SMS-SUBMIT for an short message still held in the SMSC which has the same MR and DA as a previosly submitted short message from the same OA.**

MTI:	bit1	bit0	Message type
	0	**0**	**SMS-DELIVER (SMSC ==> MS)**
	0	**0**	**SMS-DELIVER REPORT** (MS ==> SMSC, is generated automatically by the MOBILE, after receiving a SMS-DELIVER)
	0	**1**	**SMS-SUBMIT (MS ==> SMSC)**
	0	1	SMS-SUBMIT REPORT (SMSC ==> MS)
	1	0	SMS-STATUS REPORT (SMSC ==> MS)
	1	**0**	**SMS-COMMAND (MS ==> SMSC)**
	1	1	Reserved

(the fat-marked lines represent the features supported by the MOBILE)

! notice: not every PDU Type is supported by the Service Center !

3.3 Message Reference MR

SEE FIG 20

The MR field gives an integer (0..255) representation of a reference number of the SMS-SUBMIT submitted to the SMSC by the MS.

! notice: at the MOBILE the MR is generated automatically, -anyway you have to generate it-
a possible entry is for example "00H" !

3.4 Originator Adress OA Destination Adress DA

OA and DA have the same format explained in the following lines:

SEE FIG. 21

len:
The octet "len" contains the number of BCD digits

type of number:
81H: the following number is national
91H: the following number international
(for further information see GSM 04.08 chapter 10.5.4.6)

BCD-digits:
The BCD-digit Field contains the BCD-number of the Destination e.g. of the Originator
If the called party BCD number contains an odd number of digits, the last digit shall be filled with an end mark coded as "FH"

Example:
if you have the national number 1234567 you have to type:

0781214365F7

3.5 Protocol Identifier PID

SEE FIG 22

The PID is the information element by which the Transport Layer either refers to the higher layer protocol being used, or indicates interworking with a certain type of telematic device. here are some examples of PID codings:

00H: The PDU has to be treat as a short message
41H: Replace Short Message Type1
42H: Replace Short Message Type2
43H: Replace Short Message Type3
......
47H: Replace Short Message Type7

If „Replace Short Message Type x" is present, then the MS will check the associated SC address and originating address and replace any existing stored message having the same Protocol Identifier code, SC address and originating address with the new short message and other parameter values. If there is no message to be replaced, the MS shall store the message in the normal way.

(for further information see GSM 03.40 chapter 9.2.3.9)

! notice: it is not guaranteed that the SMSC supports every PID codings!

3.6 Data Coding Scheme DCS

SEE FIG 23

The DCS field indicates the data coding scheme of the UD (User Data) field, and may indicate a message class. the octet is used according to a coding group which is indicated in bits 7..4. The octet is then coded as follows:

Coding group: bits 7..4	bits 3..0

0000	**Alphabet indication** Unspecified message handling at the MS 0000 Default alphabet (7 bit data coding in the User Data) 0001-1111 reserved
0001-1110	Reserved coding groups
1111	**Data Coding/message class** **bit 3 is reserved, set 0** **bit 2** (message coding) **0** **Default alphabet (7 bit data coding in the User Data)** **1** **8-bit data coding in the User Data** **bit 1 bit 0** (message class) **0 0** Class0 immediate display **0 1** **Class1 ME (Mobile Equipment)- specific** **1 0** **Class2 SIM specific message** **1 1** **Class3 TE (Terminate Equipment)- specific**

Default alphabet indicates that the UD (User Data) is coded from the 7-bit alphabet given in the appendix. When this alphabet is used, eight characters of the message are packed in seven octets, and the message can consist of up to 160 characters (instead of 140 characters in 8-bit data coding)
In 8-bit data coding, you can relate to the INTEL ASCII-HEX table.
In Class 0 (immediate display) the short message is written directly in the display, as the M1 has no display the Class 0 message can be realised only in a roundabout way.
In Class 1 to Class 3 the short message is stored in the several equipments ME, SIM-card and TE.
In time the Class 2 is supported, if you choose Class 1 or Class 3 the short message is treated the same way as a Class 2 message.

! note: It is recommended to use the Class2 message, or the coding group "0000 bin" !

3.7 Service Center Time Stamp SCTS

The SCTS is the information element by which the SMSC informs the recipient MS about the time of arrival of the short message at the Transport Layer entity of the SMSC. The time value is included in every SMS-DELIVER being delivered to the SMSC, and represents the local time in the following way:

SEE FIG 24

The Time Zone indicates the difference, expressed in quarters of an hour, between the local time and GMT (Greenwich Main Time).

3.8 Validity Period VP

The Validity-Period is the information element which gives an MS submitting an SMS-SUBMIT to the SMSC the possibility to include a specific time period value in the short message. The Validity Period parameter value indicates the time period for which the short message is valid, i.e. for how long the SMSC shall guarantee its existence in the SMSC memory before delivery to the recipient has been carried out.

SEE FIG 25

The VP field is given in either integer or semi-octet representation. In the first case, the VP comprises 1 octet, giving the length of the validity period, counted from when the SMS-SUBMIT is received by the SMSC. In the second case, the VP comprises 7 octets, giving the absolute time of the vality period termination.
In the first case, the representation of time is as follows:

VP Value	Validity period value
0-143	(VP + 1) x 5 minutes (i.e 5 minutes intervals up to 12 hours)
144-167	12 hours + ((VP-143) x 30 minutes)
168-196	(VP-166) x 1 day
197-255	(VP - 192) x 1 week

in the second case, the representation of time is identical to the representation or the SCTS (Service Center Time Stamp)

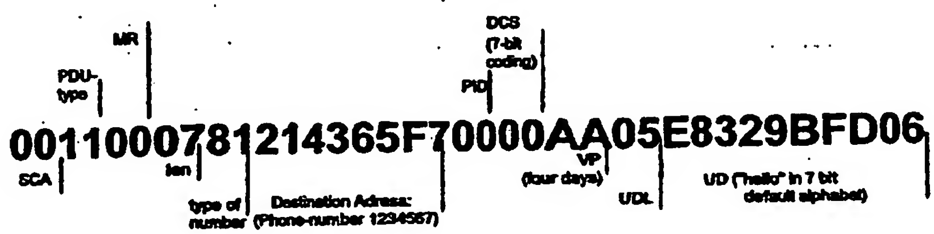
The case of representation is set in the VPF (Validity Period Format) in the PDU-type.

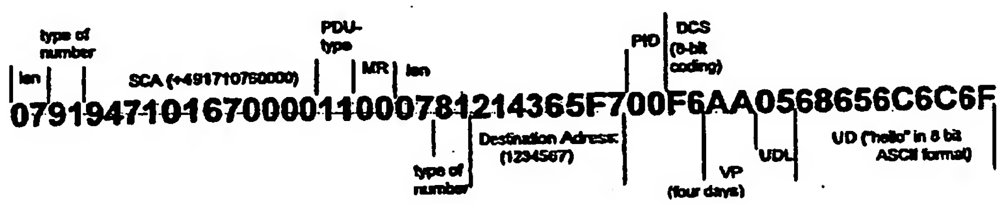
3.9 User Data Length UDL and User Data UD

SEE FIG 26

The UDL field gives an integer representation of the number of characters within the User Data field to follow.

4. PDU Examples





here are two examples how to send a short message with AT+Cellular:

first enter PIN-number and the Service Center Adress:

at+cpin="XXXX"	*enter the PIN-number*
OK	
at+csca="+491722270000"	*enter the Service-Center-Adress (here D2)*
OK	

<u>1st example:</u>

at+cmgs=140	*enter "send message", 140 is the maximum length (in byte) of the following PDU*
> 0011000781214365F70000AA05E8329BFD06	*type the PDU (SMS-SUBMIT) and finish with "ctrl Z" the thin-typed characters are the Destination Adress e.g. the own tel.-number the Service Center adress is the same as set via at+csca command*

+CMGS: 0

OK

at+cpms?	*are messages stored on the SIM-Card?*
+CPMS: "SM" , 1 , 7 , "SM" , 1 , 7	on this SIM-Card is 1 message stored
OK	you can store at most 7 messages
at+cmgr=1	*read stored message in location 1*
+CMGR: 0 ,, 24	
00040C9194718215219200006930824161840005E8329BFD06	This is a PDU (SMS-DELIVER) sent by the Service Center
OK	

2nd example:

at+cmgw=140	*write message in the memory of the SIM-card*
> 0791947101670000110007812143 65F700F6AA0568656C6C6F	*type the PDU (SMS-SUBMIT) and finish with "ctrl Z" the thin-typed characters are the Destination Adress e.g. the own tel.-number. The Service Center Adress is „+491710760000"*
+CMGW: 2	
OK	
at+cmgr=2	*read stored message in location 2*
+CMGR: 2 ,, 17	
001100078121436 5F700F6AA0568656C6C6F	this is the PDU stored in location 2
OK	
at+cmss=2	*send the message stored in location 2*
+CMSS: 3	
OK	
at+cmss=2,"7654321",129	*send the message stored in location 2 to the national (129 = 81H) destination address „7654321"*
at+cmss=2,"+4917176 54321",145	*send the message stored in location 2 to the international (145 = 91H) destination address „+4917176 54321"*
at+cpms?	*are messages stored on the SIM-Card?*
+CPMS: "SM" , 3 , 7 , "SM" , 3 , 7	on this SIM-Card are 3 message stored
OK	you can store at most 7 messages
at+cmgr=3	*read stored message in location 3*
+CMGR: 0 ,, 24	
00040C91947182152192 00F66930825194720005 68656C6C6F	This is a PDU (SMS-DELIVER) sent by the Service Center
OK	

5. Appendix

Default alphabet:

				b7	0	0	0	0	1	1	1	1
				b6	0	0	1	1	0	0	1	1
				b5	0	1	0	2	0	1	0	1
b4	b3	b2	b1		0	1	2	3	4	5	6	7
0	0	0	0	0	@	Δ	SP	0	-	P	-	p
0	0	0	1	1			!	1	A	Q	a	q
0	0	1	0	2	$	Φ	"	2	B	R	b	r
0	0	1	1	3		Γ	#	3	C	S	c	s
0	1	0	0	4		Λ		4	D	T	d	t
0	1	0	1	5		Ω	%	5	E	U	e	u
0	1	1	0	6		Π	&	6	F	V	f	v
0	1	1	1	7		Ψ	'	7	G	W	g	w
1	0	0	0	8		Σ	(	8	H	X	h	x
1	0	0	1	9		Θ	)	9	I	Y	i	y
1	0	1	0	10	LF	Ξ	*	:	J	Z	j	z
1	0	1	1	11			+	;	K	Ä	k	ä
1	1	0	0	12			,	<	L	Ö	l	ö
1	1	0	1	13	CR		-	=	M		m	
1	1	1	0	14		ß	.	>	N	Ü	n	ü
1	1	1	1	15			/	?	O		o	

abbreviations:

MS	Mobile Station
SME	Short Message Entity
SMSC	Short Message Service Center
MMI	Man Machine Interface
PDUs	Protocol Data Units
SM-AL	Short Message Aplication Layer
SM-TL	Short Message Transport Layer
SM-RL	Short Message Relay Layer
SM-LL	Short Message Link Layer
PDU Type	Protocol Data Unit Type
MR	Message Reference
OA	Originator Adress
DA	Destination Adress
PID	Protocol Identifier
DCS	Data Coding Scheme
SCTS	Service Center Time Stamp
VP	Validity Period
UDL	User Data Length
UD	User Data
RP	Reply Path
UDHI	User Data Header Indicator
SRI	Status Report Indication
SRR	Status Report Request
VPF	Validity Period Format
MMS	More Messages to Send
RD	Reject Duplicate
MTI	Message Type Indicator
ME	Mobile Equipment
TE	Terminal Equipment
SIM	Subscriber Identity Modul

error codes:

0	phone failure
1	no connection to phone
2	Phone-adaptor link reserved
3	operation not allowed
4	operation not supported
5	PH-SIM PIN necessary
10	SIM not inserted
11	SIM PIN required
12	SIM PUK required
13	SIM failure
14	SIM busy
15	SIM wrong
16	incorrect password
20	memory full
21	invalid index
22	not found
23	memory failure
24	text string too long (+CPBW)
25	invalid characters in text string
26	dial string to long
27	invalid characters in dial string
30	no network servioe
31	network timeout
100	unknown
265	PUK for theft protection necessary
266	PUK2 for SIM necessary
267	PIN2 for SIM necessary

1 Scope

This technical specification defines the language-specific requirements for GSM. These are specific codepoints required by the SMS specifications which in turn are used not only for SMS (GSM 03.40, 03.41) but also for Unstructured Data (GSM 02.90) and may additionally be used for MMI (GSM 02.30).

The specifications for the DCE/DTE interface (GSM 07.05, 07.06) will also use the codes specified herein for the transfer of SMS data to an external terminal.

2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

[1] GSM 01.04 (ETR 100): "European digital cellular telecommunication system (Phase 2); Definitions, abbreviations and acronyms".

[2] GSM 02.30 (ETS 300 511): "European digital cellular telecommunication system (Phase 2); Man-Machine Interface (MMI) of the Mobile Station (MS)".

[3] GSM 02.90 (ETS 300 549): "European digital cellular telecommunication system (Phase 2); Unstructured supplementary services operation - Stage 1".

[4] GSM 03.40 (ETS 300 536): "European digital cellular telecommunication system (Phase 2); Technical realization of the Short Message Service (SMS) Point to Point (PP)".

[5] GSM 03.41 (ETS 300 537): "European digital cellular telecommunication system (Phase 2); Technical realization of Short Message Service Cell Broadcast (SMSCB)".

[6] GSM 04.11 (ETS 300 559): "European digital cellular telecommunication system (Phase 2); Point-to-Point (PP) Short Message Service (SMS) support on mobile radio interface".

[7] GSM 04.12 (ETS 300 560): "European digital cellular telecommunication system (Phase 2); Short Message Service Cell Broadcast (SMSCB) support on the mobile radio interface".

[8] GSM 07.05 (ETS 300 585): "European digital cellular telecommunication system (Phase 2); Use of Data Terminal Equipment - Data Circuit terminating Equipment (DTE - DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)".

[9] GSM 07.06 (ETS 300 586): "European digital cellular telecommunication system (Phase 2); Use of the V series Data Terminal Equipment - Data Circuit terminating Equipment (DTE - DCE) interface at the Mobile Station (MS) for Mobile Termination (MT) configuration".

3 Definitions and abbreviations

Definitions used in this specification are listed in GSM 01.04.

4 SMS Data Coding Scheme

The TP-Data-Coding-Scheme field, defined in GSM 03.40, indicates the data coding scheme of the TP-UD field, and may indicate a message class. The octet is used according to a coding group which is indicated in bits 7..4. The octet is then coded as follows:

Coding Group Bits 7..4	Use of bits 3..0
0000	Alphabet indication Unspecified message handling at the MS. Bits 3..0 indicate the alphabet as follows: 0000 Default alphabet 0001..1111 Reserved
0001..1110	Reserved coding groups
1111	Data coding/message class Bit 3 is reserved, set to 0. Bit 2 Message coding: 0 Default alphabet 1 8-bit data Bit 1 Bit 0 Message Class: 0 0 Class 0 0 1 Class 1 default meaning: ME-specific. 1 0 Class 2 SIM-specific message. 1 1 Class 3 default meaning: TE specific (see GSM TS 07.05)

Default alphabet indicates that the TP-UD is coded from the 7-bit alphabet given in subclause 6.2.1. When this alphabet is used, the characters of the message are packed in octets as shown in subclause 6.1.2.1.1, and the message can consist of up to 160 characters. The default alphabet shall be supported by all MSs and SCs offering the service.

8-bit data indicates that the TP-UD has user-defined coding, and the message can consist of up to 140 octets.

When a mobile terminated message is class 0 and the MS has the capability of displaying short messages, the MS shall display the message immediately and send an acknowledgement to the SC when the message has successfully reached the MS irrespective of whether there is memory available in the SIM or ME. The message shall not be automatically stored in the SIM or ME.

The ME may make provision through MMI for the user to selectively prevent the message from being displayed immediately.

If the ME is incapable of displaying short messages or if the immediate display of the message has been disabled through MMI then the ME shall treat the short message as though there was no message class, i.e it will ignore bits 0 and 1 in the TP-DCS and normal rules for memory capacity exceeded shall apply.

When a mobile terminated message is Class 1, the MS shall send an acknowledgement to the SC when the message has successfully reached the MS and can be stored. The MS shall normally store the message in the ME by default, if that is possible, but otherwise the message may be stored elsewhere, e.g. in the SIM. The user may be able to override the default meaning and select their own routing.

When a mobile terminated message is Class 2 (SIM-specific), a phase 2 (or later) MS shall ensure that the message has been transferred to the SMS data field in the SIM before sending an acknowledgement to the SC. The MS shall return a "protocol error, unspecified" error message (see GSM TS 04.11) if the short message cannot be stored in the SIM and there is other short message storage available at the MS. If all the short message storage at the MS is already in use, the MS shall return "memory capacity exceeded".

When a mobile terminated message is Class 3, the MS shall send an acknowledgement to the SC when the message has successfully reached the MS and can be stored, irrespectively of whether the MS supports an SMS interface to a TE, and without waiting for the message to be transferred to the TE. Thus the acknowledgement to the SC of a TE-specific message does not imply that the message has reached the TE. Class 3 messages shall normally be transferred to the TE when the TE requests "TE-specific" messages (see GSM TS 07.05). The user may be able to override the default meaning and select their own routing.

The message class codes may also be used for mobile originated messages, to provide an indication to the destination SME of how the message was handled at the MS.

The MS will not interpret reserved or unsupported values but shall store them as received. The SC may reject messages with a Data Coding Scheme containing a reserved value or one which is not supported.

5 Cell Broadcast Data Coding Scheme

The Cell Broadcast Data Coding Scheme indicates the intended handling of the message at the MS, the alphabet/coding, and the language (when applicable). The octet is used according to a coding group which is indicated in bits 7..4. The octet is then coded as follows:

Coding Group Bits 7..4	Use of bits 3..0
0000	Language using the default alphabet Unspecified handling at the MS Bits 3..0 indicate the language: 0000 German 0001 English 0010 Italian 0011 French 0100 Spanish 0101 Dutch 0110 Swedish 0111 Danish 1000 Portuguese 1001 Finnish 1010 Norwegian 1011 Greek 1100 Turkish 1101..1110 Reserved for European languages 1111 Language unspecified
0001..0100	Reserved for European Languages using the default alphabet, with unspecified handling at the MS.
0101..1110	Reserved coding groups

1111	Data coding / message handling Bit 3 is reserved, set to 0. Bit 2 — Message coding: 0 — Default alphabet 1 — 8-bit data Bit 1 Bit 0 — Message Class: 0 0 — No message class. 0 1 — Class 1 user defined. 1 0 — Class 2 user defined. 1 1 — Class 3 default meaning: TE-specific (see GSM TS 07.05)

These codings may also be used for Unstructured SS Data and MMI/display purposes.

Messages using the default alphabet are coded with the 7-bit alphabet given in subclause 6.2.1. The message then consists of 93 user characters.

Messages using 8-bit data have user-defined coding, and will be 82 octets in length.

Class 1 and Class 2 messages may be routed by the ME to user-defined destinations, but the user may override any default meaning and select their own routing.

Class 3 messages will normally be selected for transfer to a TE, in cases where a ME supports an SMS/CBS interface to a TE, and the TE requests "TE-specific" cell broadcast messages (see GSM TS 07.05). The user may be able to override the default meaning and select their own routing.

6 Individual parameters

6.1 General principles

6.1.1 General notes

Except where otherwise indicated, the following shall apply to all alphabet tables:

1: The characters marked "1)" are not used but are displayed as a space.

2: The characters of this set, when displayed, should approximate to the appearence of the relevant characters specified in ISO 1073 and the relevant national standards.

3: Control characters:

Code Meaning

LF Line feed: Any characters following LF which are to be displayed shall be presented as the next line of the message, commencing with the first character position.

CR Carriage return: Any characters following CR which are to be displayed shall be presented as the current line of the message, commencing with the first character position.

SP Space character.

4: The display of characters within a message is achieved by taking each character in turn and placing it in the next available space from left to right and top to bottom.

6.1.2 Character packing

6.1.2.1 SMS Point-to-Point Packing

6.1.2.1.1 Packing of 7-bit characters

If a character number α is noted in the following way:

b7	b6	b5	b4	b3	b2	b1
αa	αb	αc	αd	αe	αf	αg

The packing of the 7-bits characters in octets is done by completing the octets with zeros on the left.

For examples, packing:

- one character in one octet:
  bits number:

7	6	5	4	3	2	1	0
0	1a	1b	1c	1d	1e	1f	1g

- two characters in two octets:
  bits number:

7	6	5	4	3	2	1	0
2g	1a	1b	1c	1d	1e	1f	1g
0	0	2a	2b	2c	2d	2e	2f

- three characters in three octets:
  bits number:

7	6	5	4	3	2	1	0
2g	1a	1b	1c	1d	1e	1f	1g
3f	3g	2a	2b	2c	2d	2e	2f
0	0	0	3a	3b	3c	3d	3e

- seven characters in seven octets:
  bits number:

7	6	5	4	3	2	1	0
2g	1a	1b	1c	1d	1e	1f	1g
3f	3g	2a	2b	2c	2d	2e	2f
4e	4f	4g	3a	3b	3c	3d	3e
5d	5e	5f	5g	4a	4b	4c	4d
6c	6d	6e	6f	6g	5a	5b	5c
7b	7c	7d	7e	7f	7g	6a	6b
0	0	0	0	0	0	0	7a

- eight characters in seven octets:
  bits number:

7	6	5	4	3	2	1	0
2g	1a	1b	1c	1d	1e	1f	1g
3f	3g	2a	2b	2c	2d	2e	2f
4e	4f	4g	3a	3b	3c	3d	3e
5d	5e	5f	5g	4a	4b	4c	4d
6c	6d	6e	6f	6g	5a	5b	5c
7b	7c	7d	7e	7f	7g	6a	6b
8a	8b	8c	8d	8e	8f	8g	7a

The bit number zero is always transmitted first.

Therefore, in 140 octets, it is possible to pack (140x8)/7=160 characters.

6.1.2.2 SMS Cell Broadcast Packing

6.1.2.2.1 Packing of 7-bit characters

If a character number α is noted in the following way:

b7	b6	b5	b4	b3	b2	b1
αa	αb	αc	αd	αe	αf	αg

the packing of the 7-bits characters in octets is done as follows

	Bit number							
Octet number	7	6	5	4	3	2	1	0
1	2g	1a	1b	1c	1d	1e	1f	1g
2	3f	3g	2a	2b	2c	2d	2e	2f
3	4e	4f	4g	3a	3b	3c	3d	3e
4	5d	5e	5f	5g	4a	4b	4c	4d
5	6c	6d	6e	6f	6g	5a	5b	5c
6	7b	7c	7d	7e	7f	7g	6a	6b
7	8a	8b	8c	8d	8e	8f	8g	7a
8	10g	9a	9b	9c	9d	9e	9f	9g
				.				
				.				
81	93d	93e	93f	93g	92a	92b	92c	92d
82	0	0	0	0	0	93a	93b	93c

The bit number zero is always transmitted first.

Therefore, in 82 octets, it is possible to pack (82x8)/7 = 93.7, that is 93 characters. The 5 remaining bits are set to zero as stated above.

6.2 Alphabet tables

This section provides tables for all the alphabets to be supported by SMS. The default alphabet is mandatory. Additional alphabets are optional. Irrespective of support of an individual alphabet, an MS shall have the ability to store a short message coded in any alphabet on the SIM.

6.2.1 Default alphabet

Bits per character: 7

SMS User Data Length meaning: Number of characters

CBS pad character: CR

Character table:

				b7	0	0	0	0	1	1	1	1
				b6	0	0	1	1	0	0	1	1
				b5	0	1	0	1	0	1	0	1
b4	b3	b2	b1		0	1	2	3	4	5	6	7
0	0	0	0	0	@	Δ	SP	0	¡	P	¿	p
0	0	0	1	1	£	1)	!	1	A	Q	a	q
0	0	1	0	2	$	Φ	"	2	B	R	b	r
0	0	1	1	3	¥	Γ	#	3	C	S	c	s
0	1	0	0	4	è	Λ	¤	4	D	T	d	t
0	1	0	1	5	é	Ω	%	5	E	U	e	u
0	1	1	0	6	ù	Π	&	6	F	V	f	v
0	1	1	1	7	ì	Ψ	'	7	G	W	g	w
1	0	0	0	8	ò	Σ	(	8	H	X	h	x
1	0	0	1	9	Ç	Θ	)	9	I	Y	i	y
1	0	1	0	10	LF	Ξ	*	:	J	Z	j	z
1	0	1	1	11	Ø	1)	+	;	K	Ä	k	ä
1	1	0	0	12	ø	Æ	,	<	L	Ö	l	ö
1	1	0	1	13	CR	æ	-	=	M	Ñ	m	ñ
1	1	1	0	14	Å	ß	.	>	N	Ü	n	ü
1	1	1	1	15	å	É	/	?	O	§	o	à

SECTION 1

INTRODUCTION

1.1 OVERVIEW

The GARMIN GPS 35LP is a complete GPS receiver, including an embedded antenna, designed for a broad spectrum of OEM (Original Equipment Manufacturer) system applications. Based on the proven technology found in other GARMIN 12 channel GPS receivers, the GPS 35LP will track up to 12 satellites at a time while providing fast time-to-first-fix, one second navigation updates and low power consumption. Its far reaching capability meets the sensitivity requirements of land navigation as well as the dynamics requirements of high performance aircraft.

The GPS 35LP design utilizes the latest technology and high level circuit integration to achieve superior performance while minimizing space and power requirements. All critical components of the system including the RF/IF receiver hardware and the digital baseband are designed and manufactured by GARMIN to ensure the quality and capability of the GPS 35LP. This hardware capability combined with software intelligence makes the GPS 35LP easy to integrate and use.

The GPS 35LP is designed to withstand rugged operating conditions and is completely water resistant. The GPS 35LP is a complete GPS receiver that requires minimal additional components be supplied by an OEM or system integrator. A minimum system must provide the GPS 35LP with a source of power and a clear view of the GPS satellites. The system may communicate with the GPS 35LP via a choice of two RS-232 compatible full duplex communication channels (-xVS series), or two full duplex CMOS channels (-xVC series). Internal memory backup allows the GPS 35LP to retain critical data such as satellite orbital parameters, last position, date and time. End user interfaces such as keyboards and displays are added by the application designer.

1.2 FEATURES

The GPS 35LP provides a host of features that make it easy to integrate and use.

1) Full navigation accuracy provided by Standard Positioning Service (SPS)
2) Compact design ideal for applications with minimal space
3) High performance receiver tracks up to 12 satellites while providing fast first fix and low power consumption
4) Differential capability utilizes real-time RTCM corrections producing 3-10 meter position accuracy
5) Internal clock and memory are sustained by a rechargeable memory backup battery. The battery recharges during normal operation.
6) User initialization is not required
7) Navigation mode (2D or 3D) may be configured by the user
8) Two communication channels and user selectable baud rates allow maximum interface capability and flexibility

9) Highly accurate one-pulse-per-second output for precise timing measurements. Pulse width is configurable in 20 msec increments from 20 msec to 980 msec.

10) Binary Format Phase Data Output on TXD2

11) Flexible input voltage levels of 3.6Vdc to 6.0Vdc with overvoltage protection in the -LVx versions, and 6.0Vdc to 40Vdc in the -HVx versions.

12) FLASH based program memory. New software revisions upgradeable through serial interface.

1.3 Naming Conventions

The GPS 35LP Series TrackPack™ receivers are delineated with a three letter extension to designate the operating voltage range and the serial data voltage specification.

High Voltage - GPS35-HVx designation indicates that the unit will accept a high input voltage. The internal switching regulator will operate from a 6VDC to 40VDC unregulated supply.

Low Voltage - GPS35-LVx designation indicates that the unit is designed to operated from a low voltage 3.6VDC to 6.0VDC supply. Operation at about 4VDC is the most power efficient mode of operation for the GPS35LP receiver. The unit is protected if a high voltage is inadvertently applied to the input.

RS-232 Serial Data - GPS35-xVS designation means that the two bi-directional serial data ports are true RS-232 ports conforming to the RS-232E standard.

CMOS Serial Data - GPS35-xVC designation means that the two bi-directional serial data ports use CMOS output buffers. The input buffers will accept either CMOS(TTL) voltage levels or RS-232 voltage levels. This configuration is adequate for communicating directly with serial devices over short cable lengths (less than 20 meters).

1.4 TECHNICAL SPECIFICATIONS

Specifications are subject to change without notice.

1.4.1 Physical Characteristics

1) Single construction integrated antenna/receiver.

2) Weight: 4.4 oz, (124.5 g), not including cable

3) Size: 2.230" (w) x 3.796" (l) x 1.047" (h), (56.64 mm x 96.42 mm x 26.60 mm)

1.4.2 Environmental Characteristics

1) Operating temperature: -30°C to +85°C (internal temperature)

2) Storage temperature: -40°C to +90°C

1.4.3 Electrical Characteristics

1) Input voltage: +3.6VDC to 6.0VDC regulated, 150mV ripple -LVx versions.
   +6.0VDC to 40VDC unregulated -HVx version.

2) Input current: 120 mA typical 140 mA max -LVx versions, 20 mA while in power down.
   870mW typical 1000mW max -HVx version, 300uA while in power down.

3) Backup power: 3V Rechargeable Lithium cell battery, up to 6 month charge.

4) Power Down Input: 2.7V threshold

1.4.4 Performance

1) Tracks up to 12 satellites (up to 11 with PPS active)

2) Update rate: 1 second

3) Acquisition time
   - 15 seconds warm (all data known)
   - 45 seconds cold (initial position, time and almanac known, ephemeris unknown)
   - 5.0 minutes AutoLocate ™ (almanac known, initial position and time unknown)
   - 5 minutes search the sky (no data known)

4) Position accuracy:
   Differential GPS (DGPS): 5 meters RMS
   Non-differential GPS: 15 meters RMS (100 meters with Selective Availability on)

5) Velocity accuracy: 0.2 m/s RMS steady state (subject to Selective Availability)

6) Dynamics: 999 knots velocity, 6g dynamics

7) One-pulse-per-second accuracy: +/-1 microsecond at rising edge of PPS pulse (subject to Selective Availability)

1.4.5 Interfaces

1) Dual channel CMOS/TTL level (-xVC versions) or RS-232 compatible level (-xVS versions), with user selectable baud rate (300, 600,1200, 2400, 4800, 9600, 19200)

2) NMEA 0183 Version 2.0 ASCII output (GPALM, GPGGA, GPGSA, GPGSV, GPRMC, GPVTG, PGRME, PGRMT, PGRMV, PGRMF, LCGLL, LCVTG)

   <u>Inputs</u>

   - Initial position, date and time (not required)

   - Earth datum and differential mode configuration command, PPS Enable, almanac

   <u>Outputs</u>

   - Position, velocity and time

- Receiver and satellite status
- Differential Reference Station ID and RTCM Data age
- Geometry and error estimates

3) Real-time Differential Correction input (RTCM SC-104 message types 1,2,3 and 9)
4) One-pulse-per-second timing output
5) Binary Format Phase Data

1.5 APPLICATION

SE FIG 27

SECTION 2

OPERATIONAL CHARACTERISTICS

This section describes the basic operational characteristics of the GPS 35LP. Additional information regarding input and output specifications are contained in Section 4.

2.1 SELF TEST

After input power has been applied to the GPS 35LP and periodically thereafter, the unit will perform critical self test functions and report the results over the output channel(s). The following tests will be performed:

1) RAM check

2) FLASH memory test

3) Receiver test

4) Real-time clock test

5) Oscillator check

In addition to the results of the above tests, the GPS 35LP will report software version information.

2.2 INITIALIZATION

After the initial self test is complete, the GPS 35LP will begin the process of satellite acquisition and tracking. The acquisition process is fully automatic and, under normal circumstances, will take approximately 45 seconds to achieve a position fix (15 seconds if ephemeris data is known). After a position fix has been calculated, valid position, velocity and time information will be transmitted over the output channel(s).

Like all GPS receivers, the GPS 35LP utilizes initial data such as last stored position, date and time as wel as satellite orbital data to achieve maximum acquisition performance. If significant inaccuracy exists in the initial data, or if the orbital data is obsolete, it may take 5.0 minutes to achieve a navigation solution. Th GPS 35LP Autolocate™ feature is capable of automatically determining a navigation solution without intervention from the host system. However, acquisition performance can be improved if the host system initializes the GPS 35LP following the occurrence of one or more of the following events:

1) Transportation over distances further than 1500 kilometers

2) Failure of the internal memory battery without system standby power

3) Stored date/time off by more than 30 minutes

See Section 4 for more information on initializing the GPS 35LP.

2.3 NAVIGATION

After the acquisition process is complete, the GPS 35LP will begin sending valid navigation information over its output channels. These data include:

1) Latitude/longitude/altitude

2) Velocity

3) Date/time

4) Error estimates

5) Satellite and receiver status

Normally the GPS 35LP will select the optimal navigation mode (2D or 3D) based on available satellites and geometry considerations. The host system, at its option, may command the GPS 35LP to choose a specific mode of navigation, such as 2D. The following modes are available:

1) 2D exclusively with altitude supplied by the host system (altitude hold mode)

2) 3D exclusively with altitude computed by the GPS 35LP

3) Automatic mode in which the board set determines the desired mode based on satellite availability and geometry considerations

When navigating in the 2D mode (either exclusive or automatic), the GPS 35LP utilizes the last computed altitude or the last altitude supplied by the host system, whichever is newer. The host system must ensure that the altitude used for 2D navigation is accurate since the resulting position error may be as large as the altitude error. See Section 4 for more information on altitude control.

The GPS 35LP will default to automatic differential mode – "looking" for real-time differential corrections in RTCM SC-104 standard format, with message types 1,2,3, or 9, then attempt to apply them to the satellite data, in order to produce a differential (DGPS) solution. The host system, at its option, may also command the GPS 35LP to choose differential only mode. When navigating in the differential only mode, the GPS 35LP will output a position only when a differential solution is available.

2.4 SATELLITE DATA COLLECTION

The GPS 35LP will automatically update satellite orbital data as it operates. The intelligence of the GPS 35LP combined with its hardware capability allows these data to be collected and stored without intervention from the host system. A few key points should be considered regarding this process:

1) If the receiver is not operated for a period of six (6) months or more, the unit will "search the sky" in order to collect satellite orbital information. This process is fully automatic and, under normal circumstances, will take 3-4 minutes to achieve a navigation solution. However, the host system should allow the board set to remain on for at least 12.5 minutes after the first satellite is acquired (see Section 4 for more information on status indications).

2) If the memory backup battery fails, the receiver will search the sky as described above. Should the memory battery discharge, the unit needs to be powered on for several days to insure a sufficient

recharge to maintain several months of clock operation and memory storage. System configuration information will not be lost due to battery discharge, only previous position, time and almanac data will be lost.

3) If the initial data is significantly inaccurate, the receiver perform an operation known as AutoLocate™. This procedure is fully automatic and, under normal circumstances, will require 1.5 minutes to calculate a navigation solution. AutoLocate™, unlike search the sky, does not require that the receiver continue to operate after a fix has been obtained.

SECTION 3

HARDWARE INTERFACE

3.1 MECHANICAL DIMENSIONS

The GPS 35LP is a complete GPS receiver including antenna in a uniquely styled waterproof package.

SEE FIG 28

3.2 MOUNTING CONFIGURATIONS AND OPTIONS

The following mounting options are available for the GPS 35LP. Mounting is user configurable.

3.2.1 Magnetic Mount

The magnetic mount provides a firm, removable mounting attachment to any ferrous metal surface.

SEE FIG 29

3.2.2 Trunk Lip Mount

The trunk lip mount provides a semi-permanent attachment to the trunk lip of most automobiles.

SEE FIG 30

3.2.3 Suction Cup Mount

The suction cup bracket provides a removable mounting surface attached to the inside of a vehicle's windshield.

SEE FIG 31

3.2.4 Flange Mount

The flange mount allows for a permanent installation on a flat surface. This mounting configuration is ideal in applications in which the far side of the mounting surface is inaccessible.

SEE FIG 32

3.3 CONNECTION WIRING DESCRIPTION

The GPS 35LP features a stripped and pre-tinned cable assembly for connection flexibility. The following is a functional description of each wire in the cable assembly.

Red: Vin - Regulated +3.6V to +6V, 150 mA (maximum) in the -LVx versions. Typical operating current is 120 mA. Transients and overvoltages are protected by an internal 6.8V transient zener diode and a positive temperature coefficient thermistor. With voltages greater than 6.8Vdc the zener will draw several amps of current through the thermistor, causing it to heat rapidly and eventually power the unit off, unless an external fuse blows first. When proper supply voltages are returned, the thermistor will cool and allow the GPS 35-LVx to operate. The CMOS/TTL output buffers are powered by Vin, therefore a 3.6Vdc supply will create 3.6V logic output levels.

In the -HVx versions, Vin can be an unregulated 6.0Vdc to 40Vdc, optimized for 12Vdc. Typical operating power is 800mW This voltage drives a switching regulator with a nominal 4.4Vdc output, which powers the internal linear regulators, and the CMOS output buffers.

Black: GND - Power and Signal Ground

White: TXD1 - First Serial Asynchronous Output. CMOS/TTL output levels vary between 0V and Vin in the -LVC version. In the -LVS and -HVS versions a RS-232 compatible output driver is available. This output normally provides serial data which is formatted per *"NMEA 0183, Version 2.0"*. Switchable to 300, 600, 1200, 2400, 4800, 9600 or 19200 BAUD. The default BAUD is 4800.

Blue: RXD1 - First Serial Asynchronous Input. RS-232 compatible with maximum input voltage range -25 < V < 25. This input may also be directly connected to standard 3 to 5Vdc CMOS logic. The minimum low signal voltage requirement is 0.8V, and the maximum high signal voltage requirement is 2.4V. Maximum load impedance is 4.7K ohms. This input may be used to receive serial initialization / configuration data, as specified in Section 4.1.

Purple: TXD2 - Second Serial Asynchronous Output. Electrically identical to TXD1. This output provides phase data information for software version 2.03 or above. See Appendix C for details.

Green: RXD2 - Second Serial Asynchronous Input. Electrically identical to RXD1. This input may be used to receive serial differential GPS data formatted per *"RTCM Recommended Standards For Differential Navstar GPS Service, Version 2.1"* (see Section 4 for more details).

Gray: PPS - One-Pulse-Per-Second Output. Typical voltage rise and fall times are 300 nSec. Impedance is 250 ohms. Open circuit output voltage is 0V and Vin in the -LVx versions, and 0V and 4.4V in the -HVx. The default format is a 100 millisecond high pulse at a 1Hz rate, the pulse width is programmable from a configuration command in 20msec increments. Rising edge is synchronized to the start of each GPS second. This output will provide a nominal 700 mVp-p signal into a 50 Ohm load. The pulse time measured at the 50% voltage point will be about 50 nSec earlier with a 50 Ohm load than with no load.

Yellow: POWER DOWN - External Power Down Input. Inactive if not connected or less than 0.5V. Active if greater than 2.7V. Typical switch point is 2.0V @ 0.34 mA. Input impedance is 15K Ohms. Activation of this input powers the internal regulators off and drops the supply current below 20mA in the -LVx versions, and below 1mA in the -HVx. The computer will be reset when power is restored.

Section 4
Software Interface

The GPS 35LP interface protocol design is based on the National Marine Electronics Association's NMEA 0183 ASCII interface specification, which is fully defined in *"NMEA 0183, Version 2.0"* (copies may be obtained from NMEA, P.O. Box 50040, Mobile, AL, 36605, USA) and the Radio Technical Commission for Maritime Services' *"RTCM Recommended Standards For Differential Navstar GPS Service, Version 2.1, RTCM Special Committee No. 104"* (copies may be obtained from RTCM, P.O. Box 19087, Washington, DC, 20036, USA). The GPS 35LP interface protocol, in addition to transmitting navigation information as defined by NMEA 0183, transmits additional information using the convention of GARMIN proprietary sentences.

The following sections describe the data format of each sentence transmitted and received by the GPS 35LP sensor. The baud rate selection, one-pulse-per-second output interfaces and RTCM differential GPS input are also described.

4.1 NMEA Received sentences

The subsequent paragraphs define the sentences which can be received on RXD1 by the GPS 35LP receivers. Null fields in the configuration sentence indicate no change in the particular configuration parameter.

All sentences received by the GPS 35LP must be terminated with <CR><LF>, but do not require the checksum *hh. The checksum is used for parity checking data and it is recommended that the checksum be used in environments containing high electromagnetic noise. It is generally not required in normal PC environments. Sentences may be truncated by <CR><LF> after any data field and valid fields up to that point will be acted on by the GPS 35LP.

4.1.1 Almanac Information (ALM)

$GPALM,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>,<15> *hh<CR><LF>

The $GPALM sentence can be used to initialize the receivers stored almanac information if battery back-up has failed.

<1> Total number of ALM sentences to be transmitted by the sensor board during almanac download. This field can be null or any number when sending almanac to the sensor board.
<2> Number of current ALM sentence. This field can be null or any number when sending almanac to the sensor board.
<3> Satellite PRN number, 01 to 32.
<4> GPS week number.
<5> SV health, bits 17-24 of each almanac page.
<6> Eccentricity
<7> Almanac reference time.
<8> Inclination angle.
<9> Rate of right ascension.
<10> Root of semi major axis.
<11> Omega, argument of perigee.
<12> Longitude of ascension node.
<13> Mean anomaly
<14> afo clock parameter
<15> af1 clock parameter

4.1.2 Sensor Initialization Information (PGRMI)

The $PGRMI sentence provides information used to initialize the sensor board set position and time used for satellite acquisition. Receipt of this sentence by the board set causes the software to restart the satellite acquisition process. If there are no errors in the sentence, it will be echoed upon receipt. If an error is detected, the echoed PGRMI sentence will contain the current default values. Current PGRMI defaults can also be obtained by sending $PGRMIE to the board.

$PGRMI,<1>,<2>,<3>,<4>,<5>,<6>,<7>*hh<CR><LF>

<1> Latitude, ddmm.mmm format (leading zeros must be transmitted)
<2> Latitude hemisphere, N or S
<3> Longitude, dddmm.mmm format (leading zeros must be transmitted)
<4> Longitude hemisphere, E or W
<5> Current UTC date, ddmmyy format
<6> Current UTC time, hhmmss format
<7> Receiver Command, A = Auto Locate, R = Unit Reset

4.1.3 Sensor Configuration Information (PGRMC)

The $PGRMC sentence provides information used to configure the sensor board operation. Configuration parameters are stored in non-volatile memory and retained between power cycles. The GPS 35LP will echo this sentence upon its receipt if no errors are detected. If an error is detected, the echoed PGRMC sentence will contain the current default values. Current default values can also be obtained by sending $PGRMCE to the board.

$PGRMC,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>*hh<CR><LF>

<1> Fix mode, A = automatic, 2 = 2D exclusively (host system must supply altitude), 3 = 3D exclusively
<2> Altitude above/below mean sea level, -1500.0 to 18000.0 meters
<3> Earth datum index. If the user datum index (96) is specified, fields <4> through <8> must contain valid values. Otherwise, fields <4> through <8> must be null. Refer to Appendix A for a list of earth datums and the corresponding earth datum index.
<4> User earth datum semi-major axis, 6360000.0 to 6380000.0 meters (.001 meters resolution)
<5> User earth datum inverse flattening factor, 285.0 to 310.0 (10^{-9} resolution)
<6> User earth datum delta x earth centered coordinate, -5000.0 to 5000.0 meters (1 meter resolution)
<7> User earth datum delta y earth centered coordinate, -5000.0 to 5000.0 meters (1 meter resolution)
<8> User earth datum delta z earth centered coordinate, -5000.0 to 5000.0 meters (1 meter resolution)
<9> Differential mode, A = automatic (output DGPS data when available, non-DGPS otherwise), D = differential exclusively (output only differential fixes)
<10> NMEA Baud rate, 1 = 1200, 2 = 2400, 3 = 4800, 4 = 9600, 5 = 19200, 6 = 300, 7 = 600
<11> Velocity filter, 0 = No filter, 1 = Automatic filter, 2-255 = Filter time constant (10 = 10 second filter
<12> PPS mode, 1 = No PPS, 2 = 1 Hz
<13> PPS pulse length, 0-48 = (n+1)*20msec. Example n = 4 ⇨ 100 msec pulse
<14> Dead reckoning valid time 1-30 (sec)

All configuration changes take effect after receipt of a valid value except baud rate and PPS mode. Baud rate and PPS mode changes take effect on the next power cycle or an external reset event.

4.1.4 Additional Sensor Configuration Information (PGRMC1)

The $PGRMC1 sentence provides additional information used to configure the sensor board operation. Configuration parameters are stored in non-volatile memory and retained between power cycles. The GPS 35LP will echo this sentence upon its receipt if no errors are detected. If an error is detected, the echoed PGRMC1 sentence will contain the current default values. Current default values can also be obtained by sending $PGRMC1E to the board.

$PGRMC1,<1>,<2>*hh<CR><LF>

<1> NMEA output time 1-900 (sec).

<2> Binary Phase Output Data, 1 = Off, 2 = On.

Configuration changes take effect on the next power cycle or an external reset event.

4.1.5 Output Sentence Enable/Disable (PGRMO)

The $PGRMO sentence provides the ability to enable and disable specific output sentences.

The following sentences are enabled at the factory: GPGSA, GPGSV, GPRMC, PGRME, PGRMT and PGRMV

$PGRMO,<1>,<2>*hh<CR><LF>

<1> Target sentence description (e.g., PGRMT, GPGSV, etc.)
<2> Target sentence mode, where:
0 = disable specified sentence
1 = enable specified sentence
2 = disable all output sentences
3 = enable all output sentences (except GPALM)

The following notes apply to the PGRMO input sentence:

1) If the target sentence mode is '2' (disable all) or '3' (enable all), the target sentence description is no checked for validity. In this case, an empty field is allowed (e.g., $PGRMO,,3), or the mode field may contain from 1 to 5 characters.
2) If the target sentence mode is '0' (disable) or '1' (enable), the target sentence description field must be an identifier for one of the sentences being output by the GPS 25LP.
3) If either the target sentence mode field or the target sentence description field is not valid, the PGRMO sentence will have no effect.
4) $PGRMO,GPALM,1 will cause the sensor board to transmit all stored almanac information. All other NMEA sentence transmission will be temporarily suspended.

4.2 NMEA Transmitted Sentences

The subsequent paragraphs define the sentences which can be transmitted on TXD1 by the GPS 35LP receivers.

4.2.1 Sentence Transmission Rate

Sentences are transmitted with respect to the user selected baud rate.
Regardless of the selected baud rate, the information transmitted by the GPS 35LP is referenced to the one-pulse-per-second output pulse immediately preceding the GPRMC sentence.
The GPS 35LP will transmit each sentence (except where noted in particular transmitted sentence descriptions) at a periodic rate based on the user selected baud rate and user selected output sentences. The sensor board will transmit the selected sentences contiguously. The contiguous transmission starts at a GPS second boundary. The length of the transmission can be determined by the following equation and tables:

$$\text{length} = \frac{\text{total characters to be transmitted}}{\text{characters transmitted per sec}}$$

Baud	characters_transmitted_per_sec
300	30
600	60
1200	120
2400	240
4800	480
9600	960
19200	1920

Sentence	max_characters
GPGGA	81
GPGSA	66
GPGSV	210
GPRMC	73
GPVTG	40
PGRME	35
PGRMT	50
PGRMV	32
PGRMF	82
LCGLL	41
LCVTG	37

The maximum number of fields allowed in a single sentence is 82 characters including delimiters. Values in the table include the sentence start delimiter character "$" and the termination delimiter <CR><LF>.

The factory set defaults will result in a once per second transmission at the NMEA specification transmission rate of 4800 baud.

4.2.2 Transmitted Time

The GPS 35LP receivers output UTC (Coordinated Universal Time) date and time of day in the transmitted sentences. Prior to the initial position fix, the date and time of day are provided by the on-board clock. After the initial position fix, the date and time of day are calculated using GPS satellite information and are synchronized with the one-pulse-per-second output.

The GPS 35LP uses information obtained from the GPS satellites to add or delete UTC leap seconds and correct the transmitted date and time of day. The transmitted date and time of day for leap second correction follow the guidelines in *"National Institute of Standards and Technology Special Publication 432 (Revised 1990)"* (for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC, 20402, USA).

When a positive leap second is required, the second is inserted beginning at 23h 59m 60s of the last day of a month and ending at 0h 0m 0s of the first day of the following month. The minute containing the leap second is 61 seconds long. The GPS 35LP would have transmitted this information for the leap second added December 31, 1989 as follows:

Date	Time
311289	235959
311289	235960
010190	000000

If a negative leap second should be required, one second will be deleted at the end of some UTC month. The minute containing the leap second will be only 59 seconds long. In this case, the GPS 35LP will not transmit the time of day 23h 59m 59s for the day from which the leap second is removed.

4.2.3 Global Positioning System Almanac Data (ALM)

<field information> can be found in section 4.1.1.

$GPALM,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>,<15>*hh<CR><LF>

Almanac sentences are not normally transmitted. Almanac transmission can be initiated by sending the sensor board a $PGRMO,GPALM,1 command. Upon receipt of this command the sensor board will transmit available almanac information on GPALM sentences. During the transmission of almanac sentences other NMEA data output will be temporarily suspended.

<field information> can be found in section 4.1.1.

4.2.4 Global Positioning System Fix Data (GGA)

$GPGGA,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,M,<10>,M,<11>,<12>*hh<CR><LF>

<1> UTC time of position fix, hhmmss format
<2> Latitude, ddmm.mmmm format (leading zeros will be transmitted)
<3> Latitude hemisphere, N or S
<4> Longitude, dddmm.mmmm format (leading zeros will be transmitted)
<5> Longitude hemisphere, E or W

<6> GPS quality indication,
0 = fix not available,
1 = Non-differential GPS fix available,
2 = Differential GPS (DGPS) fix available
<7> Number of satellites in use, 00 to 12 (leading zeros will be transmitted)
<8> Horizontal dilution of precision, 0.5 to 99.9
<9> Antenna height above/below mean sea level, -9999.9 to 99999.9 meters
<10> Geoidal height, -999.9 to 9999.9 meters
<11> Differential GPS (RTCM SC-104) data age, number of seconds since last valid RTCM transmission (null if non-DGPS)
<12> Differential Reference Station ID, 0000 to 1023 (leading zeros transmitted, null if non-DGPS)

4.2.5 GPS DOP and Active Satellites (GSA)

$GPGSA,<1>,<2>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<4>,<5>,<6>*hh<CR><LF>
<1> Mode, M = manual, A = automatic
<2> Fix type, 1 = not available, 2 = 2D, 3 = 3D
<3> PRN number, 01 to 32, of satellite used in solution, up to 12 transmitted (leading zeros will be transmitted)
<4> Position dilution of precision, 0.5 to 99.9
<5> Horizontal dilution of precision, 0.5 to 99.9
<6> Vertical dilution of precision, 0.5 to 99.9

4.2.6 GPS Satellites in View (GSV)

$GPGSV,<1>,<2>,<3>,<4>,<5>,<6>,<7>,...<4>,<5>,<6>,<7>*hh<CR><LF>
<1> Total number of GSV sentences to be transmitted
<2> Number of current GSV sentence
<3> Total number of satellites in view, 00 to 12 (leading zeros will be transmitted)
<4> Satellite PRN number, 01 to 32 (leading zeros will be transmitted)
<5> Satellite elevation, 00 to 90 degrees (leading zeros will be transmitted)
<6> Satellite azimuth, 000 to 359 degrees, true (leading zeros will be transmitted)
<7> Signal to noise ratio (C/No) 00 to 99 dB, null when not tracking (leading zeros will be transmitted)
NOTE: Items <4>,<5>,<6> and <7> repeat for each satellite in view to a maximum of four (4) satellites per sentence. Additional satellites in view information must be sent in subsequent sentences. These fields will be null if unused.

4.2.7 Recommended Minimum Specific GPS/TRANSIT Data (RMC)

$GPRMC,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>*hh<CR><LF>
<1> UTC time of position fix, hhmmss format
<2> Status, A = Valid position, V = NAV receiver warning
<3> Latitude, ddmm.mmmm format (leading zeros will be transmitted)
<4> Latitude hemisphere, N or S
<5> Longitude, dddmm.mmmm format (leading zeros will be transmitted)
<6> Longitude hemisphere, E or W
<7> Speed over ground, 0.0 to 1851.8 knots
<8> Course over ground, 000.0 to 359.9 degrees, true (leading zeros will be transmitted)
<9> UTC date of position fix, ddmmyy format
<10> Magnetic variation, 000.0 to 180.0 degrees (leading zeros will be transmitted)
<11> Magnetic variation direction, E or W (westerly variation adds to true course)

4.2.8 Track Made Good and Ground Speed with GPS Talker ID (VTG)

The GPVTG sentence reports track and velocity information with a checksum:

$GPVTG,<1>,T,<2>,M,<3>,N,<4>,K*hh<CR><LF>
<1> True course over ground, 000 to 359 degrees (leading zeros will be transmitted)
<2> Magnetic course over ground, 000 to 359 degrees (leading zeros will be transmitted)
<3> Speed over ground, 00.0 to 999.9 knots (leading zeros will be transmitted)
<4> Speed over ground, 00.0 to 1851.8 kilometers per hour (leading zeros will be transmitted)

4.2.9 Geographic Position with LORAN Talker ID (LCGLL)

The LCGLL sentence reports position information.

$LCGLL,<1>,<2>,<3>,<4>,<5>,<CR><LF>
<1> Latitude, ddmm.mmmm format (leading zeros will be transmitted)
<2> Latitude hemisphere, N or S
<3> Longitude, dddmm.mmmm format (leading zeros will be transmitted)
<4> Longitude hemisphere, E or W
<5> UTC time of position fix, hhmmss format

4.2.10 Track Made Good and Ground Speed with LORAN Talker ID (LCVTG)

The LCVTG sentence reports track and velocity information.

$LCVTG,<1>,T,<2>,M,<3>,N,<4>,K<CR><LF>
<1> True course over ground, 000 to 359 degrees (leading zeros will be transmitted)
<2> Magnetic course over ground, 000 to 359 degrees (leading zeros will be transmitted)
<3> Speed over ground, 00.0 to 999.9 knots (leading zeros will be transmitted)
<4> Speed over ground, 00.0 to 1851.8 kilometers per hour (leading zeros will be transmitted)

4.2.11 Estimated Error Information (PGRME)

The GARMIN Proprietary sentence $PGRME reports estimated position error information.

$PGRME,<1>,M,<2>,M,<3>,M*hh<CR><LF>
<1> Estimated horizontal position error (HPE), 0.0 to 999.9 meters
<2> Estimated vertical position error (VPE), 0.0 to 999.9 meters
<3> Estimated position error (EPE), 0.0 to 999.9 meters

4.2.12 GPS Fix Data Sentence (PGRMF)

The sentence $PGRME is GARMIN Proprietary format.

$PGRMF,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>,<15>*hh<CR><LF>
<1> GPS week number (0 - 1023)
<2> GPS seconds (0 - 604799)
<3> UTC date of position fix, ddmmyy format
<4> UTC time of position fix, hhmmss format
<5> GPS leap second count
<6> Latitude, ddmm.mmmm format (leading zeros will be transmitted)
<7> Latitude hemisphere, N or S
<8> Longitude, dddmm.mmmm format (leading zeros will be transmitted)
<9> Longitude hemisphere, E or W
<10> Mode, M = manual, A = automatic
<11> Fix type, 0 = no fix, 1 = 2D fix, 2 = 3D fix
<12> Speed over ground, 0 to 1851 kilometers/hour
<13> Course over ground, 0 to 359 degrees, true
<14> Position dilution of precision, 0 to 9 (rounded to nearest integer value)
<15> Time dilution of precision, 0 to 9 (rounded to nearest integer value)

4.2.13 Sensor Status Information (PGRMT)

The GARMIN Proprietary sentence $PGRMT gives information concerning the status of the sensor board. This sentence is transmitted once per minute regardless of the selected baud rate.

$PGRMT,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>*hh<CR><LF>
<1> Product, model and software version (variable length field, e.g., "GPS 25LP VER 1.10")
<2> ROM checksum test, P = pass, F = fail
<3> Receiver failure discrete, P = pass, F = fail
<4> Stored data lost, R = retained, L = lost
<5> Real time clock lost, R = retained, L = lost
<6> Oscillator drift discrete, P = pass, F = excessive drift detected
<7> Data collection discrete, C = collecting, null if not collecting
<8> Board temperature in degrees C
<9> Board configuration data, R = retained, L = lost

4.2.14 3D velocity Information (PGRMV)

The GARMIN Proprietary sentence $PGRMV reports three-dimensional velocity information.

$PGRMV,<1>,<2>,<3>*hh<CR><LF>
<1> True east velocity, -514.4 to 514.4 m/second
<2> True north velocity, -514.4 to 514.4 m/second
<3> Up velocity, -999.9 to 9999.9 m/second

4.3 Baud Rate Selection

Baud rate selection can be performed by sending the appropriate configuration sentence to the sensor board as described in the NMEA input sentences selection. (Section 4.1)

4.4 One-Pulse-Per-Second Output

The highly accurate one-pulse-per-second output is provided for applications requiring precise timing measurements. The signal is generated after the initial position fix has been calculated and continues until power down. The rising edge of the signal is synchronized to the start of each GPS second.

Regardless of the selected baud rate, the information transmitted by the GPS 35LP receiver is referenced to the pulse immediately preceding the NMEA 0183 RMC sentence.

The accuracy of the one-pulse-per-second output is maintained only while the GPS 35LP can compute a valid position fix. To obtain the most accurate results, the one-pulse-per-second output should be calibrated against a local time reference to compensate for cable and internal receiver delays and the local time bias.

The default pulse width is 100 msec, however; it may be programmed is 20 msec increments between 20 msec and 980 msec as described in $PGRMC Section 4.1.3 character <13>.

4.5 RTCM Received Data

Position accuracy of less than 5 meters can be achieved with the GPS 35LP by using Differential GPS (DGPS) real-time pseudo-range correction data in RTCM SC-104 format, with message types 1, 2, 3, and 9. These corrections can be received by the GPS 35LP receiver on RXD2. Correction data at speeds of 300, 600, 1200, 2400, 4800 or 9600 baud can be utilized, as the GPS 35LP automatically detects the incoming baud rate. For details on the SC-104 format, refer to RTCM Paper 134-89/SC 104-68 by the Radio Technical Commission for Maritime Services.

Appendix A

Earth Datums

The following is a list of the GARMIN GPS 35LP earth datum indexes and the corresponding earth datum name (including the area of application):

0 ADINDAN - Ethiopia, Mali, Senegal, Sudan
1 AFGOOYE - Somalia
2 AIN EL ABD 1970 - Bahrain Island, Saudi Arabia
3 ANNA 1 ASTRO 1965 - Cocos Island
4 ARC 1950 - Botswana, Lesotho, Malawi, Swaziland, Zaire, Zambia, Zimbabwe
5 ARC 1960 - Kenya, Tanzania
6 ASCENSION ISLAND 1958 - Ascension Island
7 ASTRO BEACON "E" - Iwo Jima Island
8 AUSTRALIAN GEODETIC 1966 - Australia, Tasmania Island
9 AUSTRALIAN GEODETIC 1984 - Australia, Tasmania Island
10 ASTRO DOS 71/4 - St. Helena Island
11 ASTRONOMIC STATION 1952 - Marcus Island
12 ASTRO B4 SOROL ATOLL - Tern Island
13 BELLEVUE (IGN) - Efate and Erromango Islands
14 BERMUDA 1957 - Bermuda Islands
15 BOGOTA OBSERVATORY - Colombia
16 CAMPO INCHAUSPE - Argentina
17 CANTON ASTRO 1966 - Phoenix Islands
18 CAPE CANAVERAL - Florida, Bahama Islands
19 CAPE - South Africa
20 CARTHAGE - Tunisia
21 CHATHAM 1971 - Chatham Island (New Zealand)
22 CHUA ASTRO - Paraguay
23 CORREGO ALEGRE - Brazil
24 DJAKARTA (BATAVIA) - Sumatra Island (Indonesia)
25 DOS 1968 - Gizo Island (New Georgia Islands)
26 EASTER ISLAND 1967 - Easter Island
27 EUROPEAN 1950 - Austria, Belgium, Denmark, Finland, France, Germany, Gibraltar, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland
28 EUROPEAN 1979 - Austria, Finland, Netherlands, Norway, Spain, Sweden, Switzerland
29 FINLAND HAYFORD 1910 - Finland
30 GANDAJIKA BASE - Republic of Maldives
31 GEODETIC DATUM 1949 - New Zealand
32 ORDNANCE SURVEY OF GREAT BRITAIN 1936 - England, Isle of Man, Scotland, Shetland Islands, Wales
33 GUAM 1963 - Guam Island
34 GUX 1 ASTRO - Guadalcanal Island
35 HJORSEY 1955 - Iceland
36 HONG KONG 1963 - Hong Kong
37 INDIAN - Bangladesh, India, Nepal
38 INDIAN - Thailand, Vietnam
39 IRELAND 1965 - Ireland

40 ISTS 073 ASTRO 1969 - Diego Garcia
41 JOHNSTON ISLAND 1961 - Johnston Island
42 KANDAWALA - Sri Lanka
43 KERGUELEN ISLAND - Kerguelen Island
44 KERTAU 1948 - West Malaysia, Singapore
45 L.C. 5 ASTRO - Cayman Brac Island
46 LIBERIA 1964 - Liberia
47 LUZON - Mindanao Island
48 LUZON - Phillippines (excluding Mindanao Island)
49 MAHE 1971 - Mahe Island
50 MARCO ASTRO - Salvage Islands
51 MASSAWA - Eritrea (Ethiopia)
52 MERCHICH - Morocco
53 MIDWAY ASTRO 1961 - Midway Island
54 MINNA - Nigeria
55 NORTH AMERICAN 1927 - Alaska
56 NORTH AMERICAN 1927 - Bahamas (excluding San Salvador Island)
57 NORTH AMERICAN 1927 - Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua)
58 NORTH AMERICAN 1927 - Canal Zone
59 NORTH AMERICAN 1927 - Canada (including Newfoundland Island)
60 NORTH AMERICAN 1927 - Caribbean (Barbados, Caicos Islands, Cuba, Dominican Republic, Grand Cayman, Jamaica, Leeward Islands, Turks Islands)
61 NORTH AMERICAN 1927 - Mean Value (CONUS)
62 NORTH AMERICAN 1927 - Cuba
63 NORTH AMERICAN 1927 - Greenland (Hayes Peninsula)
64 NORTH AMERICAN 1927 - Mexico
65 NORTH AMERICAN 1927 - San Salvador Island
66 NORTH AMERICAN 1983 - Alaska, Canada, Central America, CONUS, Mexico
67 NAPARIMA, BWI - Trinidad and Tobago
68 NAHRWAN - Masirah Island (Oman)
69 NAHRWAN - Saudi Arabia
70 NAHRWAN - United Arab Emirates
71 OBSERVATORIO 1966 - Corvo and Flores Islands (Azores)
72 OLD EGYPTIAN - Egypt
73 OLD HAWAIIAN - Mean Value
74 OMAN - Oman
75 PICO DE LAS NIEVES - Canary Islands
76 PITCAIRN ASTRO 1967 - Pitcairn Island
77 PUERTO RICO - Puerto Rico, Virgin Islands
78 QATAR NATIONAL - Qatar
79 QORNOQ - South Greenland
80 REUNION - Mascarene Island
81 ROME 1940 - Sardinia Island
82 RT 90 - Sweden
83 PROVISIONAL SOUTH AMERICAN 1956 - Bolivia, Chile, Colombia, Ecuador, Guyana, Peru, Venezuela
84 SOUTH AMERICAN 1969 - Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Venezuela, Trinidad and Tobago
85 SOUTH ASIA - Singapore
86 PROVISIONAL SOUTH CHILEAN 1963 - South Chile
87 SANTO (DOS) - Espirito Santo Island

88 SAO BRAZ - Sao Miguel, Santa Maria Islands (Azores)
89 SAPPER HILL 1943 - East Falkland Island
90 SCHWARZECK - Namibia
91 SOUTHEAST BASE - Porto Santo and Madeira Islands
92 SOUTHWEST BASE - Faial, Graciosa, Pico, Sao Jorge, and Terceira Islands (Azores)
93 TIMBALAI 1948 - Brunei and East Malaysia (Sarawak and Sabah)
94 TOKYO - Japan, Korea, Okinawa
95 TRISTAN ASTRO 1968 - Tristan da Cunha
96 User defined earth datum
97 VITI LEVU 1916 - Viti Levu Island (Fiji Islands)
98 WAKE-ENIWETOK 1960 - Marshall Islands
99 WORLD GEODETIC SYSTEM 1972
100 WORLD GEODETIC SYSTEM 1984
101 ZANDERIJ - Surinam
102 CH-1903 - Switzerland
103 Hu - Tzu - Shan
104 Indonesia 74
105 Austria
106 Potsdam
107 Taiwan (modified Hu-Tzu-Shan)

Appendix B

GPS 35LP Evaluation Kits

GPS 35LP evaluation materials kit (part number 010-10186-00) is available from Garmin International. This kit includes two DB-9 connectors with solder pots, various mounting brackets, hookup wire, technical specification, and software to monitor the GPS 35LP outputs and configure the receiver.

To install the evaluation and configuration software run the program, setup, by using the FILE - RUN command in Windows.

<u>NMEAVWR.EXE</u>

The **NMEAVWR.EXE** program in the GARMIN program group can accept NMEA data from either the com1 or com2 PC serial port at 1200, 2400, 4800, 9600 or 19200 baud. The default settings are com1 at 4800 baud. NMEAVWR receives NMEA sentences and displays sentence information in a formatted display on the screen.

The top portion of the screen displays the 5 character identifier of sentences received, the age in seconds since the last transmission, and a count of the number of times the sentence has been received. The middle portion of the screen displays the most recently received data in the sentence with the selected NMEA identifier (highlighted in the top portion of the screen using the arrow keys).

The lower portion contains a formatted presentation of the currently selected sentence. In addition to receiving data the program will also upload NMEA sentences to the sensor board. The ALT-U key sequence will upload the file NMEA.TXT in the current directory to the unit. Received data can also be logged to a file. NMEAVWR can be invoked from a DOS prompt with the following optional parameters:

<path>nmeavwr [/b:<baud>] [<port>] [log_file.txt]

where:

[ ]	brackets indicate optional parameters
<path>	DOS path to nmeavwr.exe if not in current directory
<baud>	baud rate
<port>	PC communications port
log_file.txt	ASCII log file of all received sentences

Example:

c:\garmin>nmeavwr /b:9600 com2 log_file.txt

If no options are used, the defaults are 4800 baud, com1, and no data logging.

<u>GPSCFG.EXE</u>

The configuration program **GPSCFG.EXE** will configure the sensor boards based on user selected parameters. Some program features include the ability to download sensor board configuration, maintain different configurations in files, and perform sensor board configurations quickly with the use of one function key. Online program help is available.

GPS25PM.EXE

The Garmin Phase Monitor Program, **GPS25PM.EXE**, provides the following functions:

- Display and log phase data output from TXD2
- Upload almanac, position, and time information via RXD2
- Download almanc and ephemeris information upon command

GPS25PM.EXE can be invoked from a DOS prompt:

<path>gps25pm.exe [/com<x>] [/b:<yyyy>]

Where

<> denotes user supplied information
[] denotes optional parameters
x is com port number (1 or 2, default is 1)
yyyy is baud rate (1200, 2400, 4800, or 9600, default is 9600)

See Appendix C for detailed description and operation of the **GPS25PM.EXE** program.

Appendix C

Phase Output Data Binary Format

Two records are transmitted once per second by the GPS 35LP. One record contains primarily post-process information such as position and velocity information. The second record contains receiver measurement information. The records are sent at a default baud rate of 9600 baud, 8 bits, no parity.

Records begin with a delimiter byte (10 hex). The second byte identifies the record type (28 hex for a position record, 29 hex for a receiver measurement). The third byte indicates the size of the data. The fourth byte is the first byte of data. The data is then followed by a chksum byte, a delimiter byte (10 hex), and an end-of-transmission character (03 hex).

Note - If RTCM-104 differential data is sent to the GPS 35LP the board will reset the Phase Output Data baud rate to the same baud rate used for RTCM-104 data. If the differential inputs are used on the GPS 35LP then the RTCM-104 data must be sent to the GPS 35LP at 9600 baud(preferred) or 4800 baud. RTCM-104, baud rates less than 4800 baud are not supported by the GPS 35LP since it would limit bus bandwidth past the point where a once per second phase output data rate could be maintained.

Position Record

- 0x10	(dle is first byte)
- 0x28	(position record identifier)
- 0x36	(size of data)
- cpo_pvt_type	(see description below)
- one byte chksum	(the addition of bytes between the delimiters should equal 0)
- 0x10	(dle)
- 0x03	(etx is last byte)

```
typedef struct
  {
  float        alt;
  float        epe;
  float        eph;
  float        epv;
  int          fix;
   double      gps_tow;
   double      lat;
   double      lon;
  float        lon_vel;
  float        lat_vel;
  float        alt_vel;
  } cpo_pvt_type;
```

alt	ellipsoid altitude (mt)
epe	est pos error (mt)
eph	pos err, horizontal (mt)
epv	pos err, vertical (mt)
fix	0 = no fix; 1 = no fix; 2 = 2D; 3 = 3D; 4 = 2D differential; 5 = 3D differential; 6 and greater - not defined

gps_tow	gps time of week (sec)
lat	Latitude (rad)
lon	Longitude (rad)
lon_vel	Longitude velocity (mt/sec)
lat_vel	Latitude velocity (mt/sec)
alt_vel	Altitude velocity (mt/sec)

Receiver Measurement Record

- 0x10	(dle is first byte)
- 0x29	(receiver record identifier)
- 0xE2	(size of data)
- cpo_rcv_type	(see below)
- one byte chksum	(the addition of bytes between the delimiters should equal 0)
- 0x10	(dle)
- 0x03	(etx)

```
typedef struct
  {
  unsigned long          cycles;
  double                 pr;
  unsigned int           phase;
  char                   slp_dtct;
  unsigned char          snr_dbhz;
  char                   svid;
  char                   valid;
  } cpo_rcv_sv_type;

typedef struct
  {
  double                 rcvr_tow;
  int                    rcvr_wn;
  cpo_rcv_sv_type        sv[12];
  } cpo_rcv_type;
```

rcvr_tow	Receiver time of week (sec)
rcvr_wn	Receiver week number
cycles	Number of accumulated cycles
pr	pseudo range (mt)
phase	to convert to (0 -359.999) multiply by 360.0 and divide by 2048.0
slp_dtct	0 = no cycle slip detected; non 0 = cycle slip detected
snr_dbhz	Signal strength
svid	Satellite number (0 - 31) Note - add 1 to offset to current svid numbers
valid	0 = information not valid; non 0 = information valid

dle and etx bytes:

Software written to receive the two records should filter dle and etx bytes as described below:

```
typedef enum
{
dat,
dle,
etx
} rx_state_type;
char                in_que[256];
int                 in_que_ptr = 0;
rx_state_type       rx_state = dat;

void add_to_que( char data )
{
#define             dle_byte 0x10
#define             etx_byte 0x03

if (rx_state == dat)
   {
   if (data == dle_byte)
      {
      rx_state = dle;
      }
   else
      {
      in_que[ in_que_ptr++ ] = data;
      }
   }
else if (rx_state == dle)
   {
   if (data == etx_byte)
      {
      rx_state = etx;
      }
   else
      {
      rx_state = dat;
      in_que[ in_que_ptr++ ] = data;
      }
   }
else if (rx_state == etx)
   {
   if (data == dle_byte)
      {
      rx_state = dle;
      }
   }

if (in_que_ptr > 255)
   {
   in_que_ptr = 0;
   }
}
```

GARMIN Phase Monitor Program - gps25pm.exe

Command Line Arguments

default:

/com1	-	selects which PC serial port to use for communication - com1, com2 (com1 default).
/b:9600	-	selects the baud rate - 1200, 2400, 4800, or 9600 (9600 default)

Description:

GPS25PM.EXE is designed to interface with a Garmin GPS 25 XL or GPS 25LP sensor boards and the GPS 35LP sensors. The program will perform the following functions:
- display and log phase data output by GPS sensors.
- upload almanac, position, and time information.
- download almanac and ephemeris information.

GPS25PM.EXE is a DOS based program and will run on IBM 80286 or greater compatible PCs.

Displayed Information:

The GPS25PM.EXE display page is divided into 3 sections. The top-most section contains the following information updated at once a second:

A. Position
    1. WGS 84 Latitude, Longitude (degrees - minutes) - 0.0001 minute resolution.
    2. Ellipsoid Altitude (meters) - 1 meter resolution.

B. Velocity
    1. Each of 3 axis (meters per second) - 0.01 m/s resolution.
    2. Altitude (meters/minute) - 1 mt/m resolution.
    3. Ground Speed (kilometers/hour) - 0.1 km/h resolution

C. Estimated Position Error - Vertical, Horizontal, Total (meters) - 1 meter resolution

D. Track - (0 - 359 degrees) - 0.1 degree resolution

E. Time
    1. GPS time (hours - minutes - seconds) - 1 sec. resolution (not leap second corrected)
    2. Receiver Time of Week (GPS seconds) - 0.00000001 sec. resolution.

The middle section contains receiver measurement information for satellites which the GPS sensor is currently tracking. This information is updated once at second:

A Satellite Number (1 - 32)

B. Signal to Noise Ratio (dbHz) - 1 dbHz resolution.

C. Phase (0 - 359 degrees) - 0.1 degree resolution.

D. Pseudo Range (meters) - 1 meter resolution.

E. Accumulated Cycles (cycles) - 1 cycle resolution.

The bottom section contains program messages. Upload and download status messages will appear here as well as any program error messages.

Commands:

D - Download Almanac:

The GPS25 sensor will be sent a command to download almanac information. GPS25PM.EXE will create the file ALMANAC.DAT and locate it the current working directory. If an ALMANAC.DAT exists in the current directory it will be over-written.

U - Upload Almanac:

The ALMANAC.DAT file located in the current working directory will be read, converted to GPS25 sensor binary format, and sent to the GPS25 sensor. This command will over-write any almanac information already in the GPS25 sensor.

E - Download Ephemeris:

The GPS25 sensor will be sent a command to download ephemeris information. GPS25PM.EXE will create the file EPHEMERS.DAT and locate it in the current working directory. If an EPHEMERIS.DAT exists in the current directory it will be over-written.

P - Position and Time Upload:

The program will prompt the user for the local time offset from UTC time. This offset is then used to determine UTC time from the PC's real time clock. The UTC time is then uploaded to the GPS25 sensor. If an error occurs in the upload process a 'COMM ERROR' will be enunciated on the screen. After the UTC time has been uploaded the user is prompted for Latitude and Longitude for position uploading. An integer Latitude and integer Longitude should be entered on the same line separated by a space. If the board has not yet obtained a position fix it will restart its startup sequence based on the new position and time information.

R - Record Data

The program will prompt the user for a data file name. GPS25XL.DAT is the default. Once the file name is obtained all information displayed in the top two sections of the screen will be formatted and written to the data file. The format of this data file is described in the File Formats section. If the R option is selected again, the current file will be saved and closed and a new file will be opened. Data files will be over-written if same names are used.

File Formats

ALMANAC.DAT

Example almanac entry:

**** Week 794 almanac for PRN-01 ************	
ID:	01
Health:	000
Eccentricity:	3.414630890E-003
Time of Applicability(s):	380928.0000
Orbital Inclination(rad):	9.549833536E-001
Rate of Right Ascen(r/s):	-7.771752131E-009
SQRT(A) (m^1/2):	5153.589843
Right Ascen at TOA(rad):	8.032501489E-002
Argument of Perigee(rad):	-1.308424592E+000
Mean Anom(rad):	2.045822620E+000
Af0(s):	9.536743164E-007
Af1(s/s):	8.367351256E-011
week:	794

Almanac information for satellites with a bad health status will not be included in this file when downloaded from the GPS25 sensor and should not be included when uploading to the GPS25 sensor.

EPHEMERS.DAT

Example ephemeris entry:

**** Week 794. Ephemeris for PRN-18 **********	
Ref Time of Clk Parms(s):	233504.000000
Ref Time of Eph Parms(s):	233504.000000
Clk Cor, Group Dly(s):	-8.280389E-006
Clk Correction af1(s/s):	-3.410605E-013
Clk Correction af2(s/s/s):	0.000000E+000
User Range Accuracy(m):	33.299999
Eccentricity(-):	5.913425E-003
SQRT(A) (m**1/2):	5.153628E+003
Mean Motion Cor(r/s):	4.710911E-009
Mean Anomaly(r):	6.033204E-001
Argument of Perigee(r):	1.418009E+000
Right Ascension(r):	3.520111E-002
Inclination Angle(r):	9.434418E-001
Rate of Right Asc(r/s):	-8.210699E-009
Rate of Inc Angle(r/s):	4.503759E-010
Lat Cor, Sine(r):	1.212582E-005
Lat Cor, Cosine(r):	2.004206E-006
Inc Cor, Sine(r):	-1.490116E-008
Inc Cor, Cosine(r):	-9.872019E-008
Radius Cor, Sine(m):	38.375000
Radius Cor, Cosine(m):	132.937500
Issue of Data :	184

Ephemeris Record

- 0x10 (dle is first byte)
- 0x2A (ephemeris record identifier)
- 0x74 (size of data)
- eph_type (see description below)
- one byte chksum (the addition of bytes between the delimiters should equal 0)
- 0x10 (dle)
- 0x03 (etx)

```
typedef struct          /* ephemeris record */
  {
  char   svid;          /* Satellite number (0 - 31)                          */
  int    wn;            /* week number (weeks)                                */
  float  toc;           /* reference time of clock parameters (s)             */
  float  toe;           /* reference time of ephemeris parameters (s)         */
  float  af0;           /* clock correction coefcnt - group delay (s)         */
  float  af1;           /* clock correction coefficient (s/s)                 */
  float  af2;           /* clock correction coefficient (s/s/s)               */
  float  ura;           /* user range accuracy (m)                            */
  double e;             /* eccentricity (-)                                   */
  double sqrta;         /* square root of semi-major axis (a) (m**1/2)        */
  double dn;            /* mean motion correction (r/s)                       */
  double m0;            /* mean anomaly at reference time (r)                 */
  double w;             /* argument of perigee (r)                            */
  double omg0;          /* right ascension (r)                                */
  double i0;            /* inclination angle at reference time (r)            */
  float  odot;          /* rate of right ascension (r/s)                      */
  float  idot;          /* rate of inclination angle (r/s)                    */
  float  cus;           /* argument of latitude correction, sine (r)          */
  float  cuc;           /* argument of latitude correction, cosine (r)        */
  float  cis;           /* inclination correction, sine (r)                   */
  float  cic;           /* inclination correction, cosine (r)                 */
  float  crs;           /* radius correction, sine (m)                        */
  float  crc;           /* radius correction, cosine (m)                      */
  byte   iod;           /* issue of data                                      */
  } eph_type;
```

To initiate an ephemeris download for all tracked satellites send the following bytes in sequence:

0x10, 0x0D, 0x04, 0x02, 0x0C, 0x0, 0x0, 0xE1, 0x10, 0x03

GPS25PM.DAT

Example data file entry:

```
TIM time_of_week week_number
RCV svid snr (T)rack/(C)ycle_slip phase pseudo_range cycles
PVT time lat lon alt lat_vel lon_vel alt_vel epe eph epv
TIM 235537.99855650 794
RCV 18 50 T 120.2 19964528.44 2068193
RCV 29 50 T 133.2 20364313.25 1950557
RCV 28 45 T 176.5 21135153.13 2069992
RCV 19 47 T 145.2 21190271.83 2182643
RCV 31 45 T 75.8 21240354.20 2216421
RCV 22 42 T 195.1 22849183.41 1855826
RCV 27 36 T 155.2 24234175.55 2230462
RCV 14 39 T 202.3 25147694.34 1845263
PVT 235537.99999842 38.9499588 94.7463684 211.7 -0.19 -0.31 0.13 28 16 23
TIM 235538.99853500 794
RCV 18 50 T 38.8 19958107.10 2101947
RCV 29 50 T 132.4 20358247.54 1982431
RCV 28 45 T 189.5 21128713.01 2103829
RCV 19 47 T 284.6 21183470.16 2218374
RCV 31 45 T 19.0 21233441.89 2252746
RCV 22 42 T 263.0 22843381.08 1886300
RCV 27 36 T 311.7 24227194.88 2267146
RCV 14 39 T 308.3 25141899.86 1875708
PVT 235538.99999827 38.9499550 94.7463684 212.6 -0.19 -0.30 0.14 28 16 23
TIM 235539.99851349 794
RCV 18 50 T 76.6 19951681.26 2135704
RCV 29 50 T 284.4 20352180.11 2014308
RCV 28 45 T 320.8 21122272.68 2137669
RCV 19 47 T 8.3 21176671.33 2254110
RCV 31 45 T 170.2 21226528.82 2289074
RCV 22 42 T 315.9 22837584.50 1916778
RCV 27 36 T 132.4 24220207.85 2303835
RCV 14 39 T 127.4 25136106.23 1906158
PVT 235539.99999812 38.9499512 94.7463684 213.5 -0.19 -0.30 0.13 28 16 23
TIM 235540.99849199 794
RCV 18 50 T 174.9 19945258.21 2169465
RCV 29 50 T 177.7 20346113.87 2046190
RCV 28 45 T 159.6 21115834.07 2171514
RCV 19 47 T 324.7 21169868.61 2289849
RCV 31 45 T 111.8 21219615.05 2325407
RCV 22 42 T 261.7 22831782.87 1947261
RCV 27 36 T 259.1 24213226.41 2340528
RCV 14 39 T 318.7 25130310.86 1936612
PVT 235540.99999797 38.9499474 94.7463760 214.4 -0.19 -0.30 0.14 28 16 23
TIM 235541.99847244 794
RCV 18 50 T 325.5 19938831.69 2203229
RCV 29 50 T 152.1 20340045.44 2078075
RCV 28 45 T 52.4 21109392.21 2205362
RCV 19 47 T 125.3 21163068.15 2325593
RCV 31 45 T 159.4 21212700.30 2361743
RCV 22 43 T 117.1 22825981.54 1977748
RCV 27 36 T 352.1 24206248.88 2377225
RCV 14 39 T 141.3 25124515.72 1967071
PVT 235541.99999977 38.9499474 94.7463760 215.4 -0.19 -0.30 0.13 28 16 23
```

CLAIMS

1. A locating system comprising:

a mobile transmitter/receiver;

a global positioning receiver coupled to the mobile transmitter/receiver and which can generate positional data defining its position by obtaining data from one or more relevant global positioning transmitters selected from an array of global positioning transmitters, a remote central computer which can communicate with the mobile transmitter/receiver and which when actuated can, in response to the general location of the mobile transmitter/receiver, supply the global positioning receiver through the mobile transmitter/receiver with assistance to select the relevant one or more global positioning transmitters from said array of global positioning transmitters, said global positioning receiver, when actuated, being thereafter able to transmit said positional data to the central computer via said mobile transmitter/receiver.

2. A system according to Claim 1, wherein said general location of the mobile transmitter/receiver to which the central computer responds is that location established on the last occasion that the mobile transmitter/receiver was used.

3. A system according to Claim 1, wherein the said general location of the mobile transmitter/receiver used by the central computer is established in real time.

4. System according to any one of Claims 1 to 3, wherein the mobile transmitter/ receiver comprises a mobile telephone and said remote central computer is coupled to the mobile telephone through a telephone network.

5. A system according to Claim 4, including actuation means located with said global positioning receiver and said mobile transmitter receiving and operable when actuated to actuate the global positioning transmitter and through said mobile transmitter/receiver to actuate said central computer.

6. A system according to Claim 5, wherein the actuating means stores the telephone number through which the central computer can be accessed.

7. A system according to any one of Claims 4 to 6, wherein said positional data is delivered to the central computer using a short message service channel.

8. A system according to any one of Claims 4 to 7, wherein the central computer stores the telephone number of the mobile telephone calling it.

9. A system according to any preceding claim, including means located with the mobile transmitter receiver and the global positioning receiver for indicating that the global positioning receiver is calculating updated positional information.

10. A system according to any preceding claim, including means located with the mobile transmitter/receiver for indicating an error in the transmission of the positional data to the central computer.

11. A locating system substantially as hereinbefore described, with reference to the accompanying drawings.

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INVESTOR IN PEOPLE

Application No: GB 0111973.4
Claims searched: 1-11
Examiner: Richard Kerslake
Date of search: 20 January 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1,3-5,7,9	GB 2347035 A	(SYMMETRICOM) Figure 1, Page 3 Line 14 - Page 5 Line 21 & Page 10 Lines 2-3
X	1,3,4,7	US 6222483 B1	(TWITCHELL et al.) Figure 2 & Column 4 Lines 9-34
X	1,3,4,7	US 6081229 A	(SOLIMAN et al.) Figure 2 & Column 2 Lines 19-40
X	1,3,4,7	US 6070078 A	(CAMP, JR. et al.) Figure 1 & Column 2 Lines 25-54
X	1,3,4	EP 0874248 A2	(LOCKHEED MARTIN) See whole document esp. figure 2
X	1,3,4	US 6266533 B1	(ZADEH et al.) Figure 2 & Column 5 Lines 23-53
X	1,3,4	US 6188351 B1	(BLOEBAUM) Figure 1a & Column 8 Lines 18-40
A	-	DE 29822493 U1	(DUERRSTEIN) Figure 2 & WPI Abstract

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{V}:

H4D,H4L

Worldwide search of patent documents classified in the following areas of the IPC^{7}:

G01S, H04Q

The following online and other databases have been used in the preparation of this search report:

EPODOC, JAPIO, WPI